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USSR Report

SCIENCE AND TECHNOLOGY POLICY

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CONTENTS

ORGANIZATION, PLANNING AND COORDINATION

Elaborating a Coordinated Sectorial Plan
(M. I. Belkin, I. G. Bogorodskiy, et al.; EKONOMIKA I MATEMATICHESKIYE METODY, No 3, 1986)..... 1

Development of Mathematic Economics Instrumentarium at Present Stage
(Valeriy Leonidovich Makarov; EKONOMIKA I MATEMATICHESKIYE METODY, No 3, 1986)..... 13

Reorganization of Sectorial Science, Enterprises
(NTR: PROBLEMY I RESHENIYA, No 11, 3-16 Jun 86)..... 30

Editorial Comment 30
Sectorial Scientific Research Institutes, by V. Vashchenko 30
Avoid Equalization of Enterprises, Valeriy Leonidovich Makarov Interview 34
Chermetmekhanizatsiya Scientific Production Association, Viktor Grigoryevich Urchukin Interview 38

Measuring of Electricity, Heat, Gas, Water Consumption
(O. Lebedeva; NTR: PROBLEMY I RESHENIYA, No 2, 8-21 Apr 86)..... 40

FACILITIES AND MANPOWER

Frolov on Tasks of Machine Science Institute, Affiliates
(Konstantin Vasilyevich Frolov Interview; NTR:
PROBLEMY I RESHENIYA, No 8, 22 Apr-5 May 86)..... 52

AUTOMATION AND INFORMATION POLICY

Automated Systems of Petroleum, Gas Industry Construction
(NTR: PROBLEMY I RESHENIYA, No 10, 20 May-2 Jun 86)..... 60

System of Information on Future Equipment
(M. Karpunin, R. Vcherashniy; NTR: PROBLEMY I RESHENIYA,
No 10, 20 May-2 Jun 86)..... 62

Briefs
Riga Computer-Aided Design Center 71
Automation of Kataisi Dye Plant 71
Arsenal Plant Flexible Machine System 71

INDUSTRIAL AND COMMERCIAL APPLICATION

Developments of Institute of Machine Science
(NTR: PROBLEMY I RESHENIYA, No 8, 22 Apr-5 May 86)..... 72

Instruments of Spektr Scientific Production Association
(V. V. Klyuyev Interview; NTR: PROBLEMY I RESHENIYA,
No 8, 22 Apr-5 May 86)..... 74

Briefs
Equipment Developed by Students 77
Sibir Shaft Sinking Complex 77

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ORGANIZATION, PLANNING AND COORDINATION

ELABORATING A COORDINATED SECTORIAL PLAN

Moscow EKONOMIKA I MATEMATICHESKIYE METODY in Russian Vol 22 No 3, 1986 pp 285-293

[Article by M.I. Belkin, I.G. Bogorodskiy and A.B. Pomanskiy, Volgograd--Moscow; the article was published under the rubric "Sectorial Planning and Management"]

[Text] Introduction

One of the important tasks in the program for a comprehensive improvement in the national economic mechanism is a better planning system. Under the conditions of the increased production volume, the wider and more complex range of produced products, the elaboration of a plan which is not only optimum but even balanced for the entire aggregate of indicators and standards of resource utilization using traditional methods is a very labor-intensive task. Without the automating of the decision-taking process, particularly in sectors involved in small-series and single-unit types of production, the optimizing of planning quotas within the dates set by directive for working out the annual plans of the subsectors, enterprises and production associations is virtually impossible. Thus, for a subsector which includes three associations and ten independent enterprises, in calculating ten variations of the annual plan for each enterprise, according to the standards of Soyuzmashuchet [All-Union Association for the Production of Accounting Machinery], some 123.8 man-days would be needed merely to carry out the arithmetical operations with manual processing of the information. The time required to analyze the results and correct them would naturally be several-fold more.

The automating of logical and computational operations changes the functions of planning specialists. With machine processing of the data, these functions are incorporated in the formulating of the goals and constraints, their quantitative evaluation as well as in the informal analysis of alternate decisions generated by the computer in the planning process.

For ensuring the effectiveness of the automated elaboration of plans, it is essential, in the first place, to improve the skills of the planning specialists and broaden their erudition both in economics as well as in production equipment and methods. In essence, under these conditions, a planner acts in the role of a skilled expert who within rather fixed times

should be able to take a decision on one or another economic alternative and correspondingly knowledge is required of him in all areas of economics (production, labor and wages, costs, finances, bookkeeping and operational accounting). Secondly, the expert should have a direct link with a computer. Ultimately, it is essential to develop an automatic work station for a planner.

Unfortunately, at times, in being involved with the theoretical orderliness of the problem or attempting to give the computer too many stages in compiling a plan, the developers end up in a blind alley in the stage of introducing the automated system. In our view, the reason for such failures is tied to the necessity of modifying the existing logic of planning calculations. Then, in addition to the problems of a psychological sort, significant organizational and informational difficulties arise.

For example, it is frequently not considered that the forming of the basic technical and economic indicators in an annual plan proceeds not simultaneously with its compiling by product range. Such a situation has been brought about by a number of objective factors, in particular, by the high level of planning centralization which, combined with the multisectorial management system for the national economy, requires the successive forming of the plan; it is also brought about by the structure of the planning bodies.

Not yet sufficiently studied are the questions of the completeness and reliability of the initial information received from the enterprises in the sector and the methods of decision taking under conditions of ambiguity are not correspondingly provided. As a consequence, in operating an automated system, time is spent on receiving and clarifying information while the time for calculating the plan on the computer is excessively drawn out. Along with this the traditional calculation methods always make it possible to promptly draw up an approximate sketch of the plan and adjust it as supplementary data are received.

In the sectorial automated systems, they often make provision for the simultaneous examination of the entire range of interrelated indices, norms and constraints with the turning out of a set of plan indicators obtained as a result of the calculation for the user. However, such an approach is not adequate to the course of reasoning for a planner. An iterative process of "figuring out bottlenecks" more naturally conforms to his logic: at each specific moment the attention of the expert planner is focused on a comparatively small group of indicators. First he works to balance the quota, gradually broadening the range of indicators being analyzed and only then endeavors to improve this while the criteria of effectiveness are not always subject to formalization.

The scientific research organizations of the USSR Minkhimmash [Ministry of Chemical and Petroleum Machine Building] together with the TsEMI [Central Mathematical Economics Institute] for a number of years have been working to improve planning in the subsector of petrochemical machine building. In the course of the research a data of simulation models of the subsector enterprises has been built and a method for compiling coordinated plans has been worked out. A base model described in [1] and in more detail in [2] has

served as the basis for the models of the enterprises. Below we describe the general principles on the basis of which the simulation model bank oriented at real operating conditions in the sector was developed and gained actual use in the planning process.

Principles for Modeling Relationships in the System of Sectorial Planning

The economic interests of the direct producer enterprises have a substantial impact on the results of fulfilling the sectorial plan. A mismatching of economic interests at times leads to the distorting of information transmitted by the enterprises to the superior administrative bodies, in particular to the down-playing of production capabilities and to the inflating of needs for materials and other resources. It is essential to consider the consequences of setting different economic norms: the fund-correcting indicators, the norms for the formation of the wage fund, profit distribution and so forth.

In a most general form, the problem of optimum management can be written in the following manner: for each conceivable range of management actions $u=\{u_i\}$ there is a corresponding vector $\hat{x}(u)$ characterizing the results of enterprise operations. Let $D(x, u)$ be the function assessing the results of enterprise activities from the viewpoint of the planning body and the corresponding variation of managing (incentive) actions. Then the problem of optimum management consists in choosing that variation of managing actions whereby one achieves the maximum $D(\hat{x}(u), u)$.

The variations of managing actions here are understood in the broadest sense, $u=\{u_i\}$ depends upon x. In particular, u(x) presupposes a rule (mechanism) for forming the material incentive funds in accord with the results of enterprise operations and not a set of fund-correcting norms with set indicators included among the fund-forming ones. Among the managing indicators, their naturally are also quotas for the output of individual product types and for the growth of technical and economic performance.

A solution to the formulated problem requires complete information on the capabilities and interests of the enterprises, that is, a knowledge of the dependences x(u) with all the admissible values of u(x). A possible approach to solving this problem presupposes the constructing of adequate simulation models of real enterprises which serve as a tool for obtaining the necessary dependences $\hat{x}(u)$. Such models are designed to forecast plan fulfillment, more accurately for working out a mutually coordinated system of plan quotas. In addition, they can also be useful in the prompt adjusting of the main indicators of enterprise operations over the year. Finally, in incorporating the corresponding changes in the formal relationships, such models make it possible to examine the effect of proposed modifications of the economic mechanism on the output of products as well as other economic indicators.

In modeling the relations which exist in a two-level management system of "sector--enterprise," as a rule, it is procedurally easy to formalize a description of the lower level of the hierarchy. For this it is essential to describe the multiplicity of enterprise production capabilities and indicate its effectiveness function. The differences in the enterprise models come

down primarily to an emphasis of one or another particular feature of specific production.

It is not always possible to uniformly determine the role and place of one or another factor in the system being modeled. In particular, this applies to labor resources. At enterprises which have a manpower shortage, the opportunities of controlling the quantitative and qualitative composition of the employees are very limited. In such instances it is advisable to view labor expenditures as an exogenic resource which determines a multiplicity of production programs being realized. If an enterprise can actively influence the size and structure of the employees, then the labor expenditures operate as an endogenic resource the volume of which is a function of the production program determined from various considerations.

The difference between the exogenic and endogenic resources is fundamental for an analysis of the relationships between a sector and its enterprises. The sectorial planning body controls the distribution of only the exogenic resources for the enterprises.

Along with resources a sector distributes the production program between the enterprises. An enterprise in the general instance has specialized capacity which is employed for producing a strictly determined product. The possibility of such redistribution depends upon the availability of unspecialized or the same type capacity at the enterprises. Specialization limits the sectorial planning body in the redistribution of quotas for product output.

The main task of a sectorial planning body is the optimum distribution of the plan according to nonspecialized product types and the establishing of the necessary volumes of resources which are exogenic from the viewpoint of the enterprises. Here the most difficult to define is the concept of plan optimality. In examining a two-level model, one must consider the incompatibility of the aims in the elements of the different levels of the hierarchy. In analyzing the operating results of a specific enterprise, with a significant degree of reliability one can disclose the type of its effectiveness function.

To a greater or lesser degree an enterprise endeavors to optimize all the most important technical and economic indicators. A sound conclusion on the ranking of indicators in the effectiveness function can be drawn only after the appropriate quantitative analysis or as a result of an expert evaluation. Expert evaluations on the importance of enterprise goals can be reinforced by an analytical approach based upon quantitative retrospective analysis.

An enterprise is economically interested in fulfilling the plan, since the plan is tied to such operating results as profit, material incentive funds, wages and so forth. The noneconomic indicators and factors must be linked to this. In contrast to the noneconomic indicators and factors, the economic ones are observable in an obvious form and using retrospective data it is possible to "recreate" the effectiveness function of the enterprise in their space.

The essence of the calculations comes down to the following procedure. Let $E_1,..,E_n$ -- the set of base economic indicators which depend upon the enterprise operating results. Let us examine the effectiveness function in the form of

$$G(x) = \sum_{i=1}^{n} w_i E_i(x),$$

where x -- the vector of the independent technical and economic indicators (with the exception of the base ones) for enterprise operations according to the results of the year. Let us assume that the effectiveness function is characterized most adequately by that set of values of w_i and the optimum solution for this corresponds most accurately to the actual results of enterprise operations.

Let x^+ -- the vector of the known technical and economic indicators of enterprise operations in year t preceding the calculated one. Let us assume that the enterprise functioned in an optimum manner for itself, that is, with $x=x^+$ a maximum of its effectiveness function is achieved. We will determine the vector w_t^* in such a manner that a minimum deviation of the calculated indicators $\bar{x}^{+t}$ from the actual x^+ is achieved, where $\bar{x}^+$ -- the optimum solution to the problem

$$G(x) = \sum_{i=1}^{n} w_i E_i(x) \to \max, \quad x \in X^+,$$

but X^+ -- the set of technologically and economically acceptable variations for the operation of the enterprise in year t.

In other words,

$$w^t = \arg\min_{w} \rho\left(x^t, \arg\max_{x \in X^t} \sum w_i E_i(x)\right), \tag{1}$$

where $\rho(x^t, \bar{x}^t)$ -- the selected evaluation function of deviation.

The expression (1) is a problem of mathematical programming in the space of coefficients w_i of the effectiveness function of enterprise operations. The minimizing functional of problem (1) represents a quantitative evaluation of the discrepancy of the actual enterprise operating indicators and the results of calculating the optimum variation for the efficiency function. The found vector w^t with a known degree of objectivity reflects the economic interests of the enterprise in year t. For obtaining the effectiveness criterion for enterprise operations in planning year T, it is essential to extrapolate the sequence of vectors w^+ for this year.

The described approach requires several explanations. In the first place, the results of evaluating the efficiency function depend upon the set of base indicators which should be determined from meaningful economic considerations.

In each specific instance, the number of indicators selected as base ones is small. Secondly, the soundness of selecting the hypothesis of the effectiveness function of enterprise operations depends upon the freedom of varying vector x. A too large number of conditions in describing set X leads to the lack of an alternate choice of x and to the indistinguishability of the hypotheses. Finally, the observations should be compatible with one another. This is achieved if over the period being analyzed the external conditions and rules for evaluating enterprise operations remain comparatively stable. For assessing the degree of deviation of the calculated indicators from the actual ones, it is best to view not their physical values but rather indices. Then as the evaluation function it is possible to take

$\rho(x^t, \bar{x}^t) = \sqrt{\sum_k (\bar{x}_k^+ - x_k)^r}$, where k -- the number of the independent variable.

We have made such calculations for 1980. Chosen as the base indicators were: the growth rate of average wages of industrial personnel -- 1, labor productivity -- 2 and balance sheet profit -- 3, as well as the fulfillment of the plan for product range -- 4.

The first two indicators can be considered crucial for the enterprises which operate under the conditions of a manpower shortage and are interested in increasing employee skill and raising the efficient use of labor resources. The third indicator is important for enterprises which are in the stage of reconstruction and require a large amount of profit which could go into capital investments.

The incorporation of the fourth indicator which, generally speaking, must be considered the effectiveness function of the sector's operations as a whole is valid for the following reasons. In the first place, using such a calculation it is possible to assess the maximum possible level of national economic demand for the most important product types. Secondly, a comparison of the optimum results from operating using "external" and "internal" criteria makes it possible to assess the degree of discrepancy between the interests of the sector and the enterprises.

The obtained results show that the best matching of the actual and calculated data was with $w_1=2$, $w_3=1$, $w_2=w_4=0$. This is sufficiently typical for enterprises of small-series production which have a shortage of skilled employees. The weak influence of the indicator for the fulfillment of the plan by product range was basically brought about by the high demand for the produced product and, consequently, a certain freedom of the enterprise in maneuvering the assortment.

In [3] they analyze the model of encouraging the fulfillment of the production plan and where by changing the method for calculating the share of profit left at the enterprise's disposal, the plan set for it is more preferential in terms of profit. In essence the question comes down to introducing sectorial surcharges on the price of the product and the amount of the surcharge is

related to the degree of fulfilling the product range plan. We have carried out calculations on adequate models which have shown that small sectorial surcharges and rebates in the price for a product could be an effective means for specializing production in an area corresponding to the interests of the sector as a whole. A thorough analysis of the principles of price formation and the employment of prices as a tool for optimum national economic management can be found in [4]. This article examines the procedure for constructing a sectorial plan employing only those means of influencing the enterprises and which the sector has available with the existing planning system. Such modeling of the impact of economic regulators on enterprise operations was discussed in [1]. We will give only the most general considerations.

The means for a sector's influence on the choice of a production program by an enterprise can be divided into two groups.

The first includes the norms for profit distribution and the formation of economic incentive funds as well as the normative constraints on the ratio of the growth rates for individual indicators. This is a rather flexible tool the use of which does not involve reorganizations of the production structure or the system of relationships between suppliers and consumers. A qualitative description of the impact of the norms on enterprise economic operations comes down to the following.

Whatever the effectiveness function of an enterprise (profit, economic incentive funds or wages), this is basically determined by two groups of factors: by the values of the fund-forming norms and by the amounts of the fund-forming indicators (planned profit, normed net product, labor productivity, the proportional amount of superior quality products and consumer goods, the percentage of fulfilling the delivery plans and product costs). The technical and economic indicators are a consequence of the production program implemented at the enterprise. With set values for the norms, an enterprise focuses attention on those indicators which most effectively influence its effectiveness function. In changing the value of the norms, a sectorial planning body influences the enterprise's notion of the relative importance of the fund-forming indicators and the enterprise is forced to revise the production program which is optimum from its viewpoint. Thus, in modeling the sectorial planning system, the fund-forming norms are primarily a means of controlling the effectiveness function of enterprise operations.

The second group is the planning quotas for producing the most important product types in physical units (the product range plan). Regardless of a certain economic independence, the freedom to maneuver for an enterprise is very restricted in carrying out such a plan. This is due primarily to the plan's supply by centrally managed stocks of the main types of material resources. In comparison with the norms, the product range plan has a significantly stronger influence on enterprise operations, since supply with exogenic resources is one of the most important factors determining the set of its production capabilities.

In many planning models it is assumed that resources are the chief means for optimizing a sectorial plan. With all the enticingness of such an approach, one must also remember its negative aspects. High production specialization which is characteristic of the present industrial development level limits the possibility of a sector to redistribute product output between enterprises. In the first place, this is explained by the additional outlays to prepare production in switching to the output of new product types. Secondly, changes in material-technical supply and marketing, that is, in the structure of the ties between suppliers and consumers, require definite expenditures. Nor should one underestimate the subjective factor of inertia in production and management.

In any account, for a sectorial planning body there is a natural desire without extreme necessity not to increase the sectorial outlays. For current planning this means to adhere to the sectorial production structure which had developed in previous years.

Determining the effectiveness function in the activities of a sectorial planning body is one of the key questions in modeling the sectorial systems. This body is in essence the coordinator of actions for the immediate producers, the enterprises. For this reason the given article adopts the hypothesis that the goal of its activity is to ensure stable management of the sector. By stable management one understands the protection of it against random disturbances related to interruptions in deliveries, fluctuations in personnel, delays in payments and other unforeseen effects in the environment where the sector functions. Years-long experience makes it possible for the planning bodies to acquire statistics on such random disturbances and draw conclusions on the bottlenecks in the sectorial economic mechanism.

The aim of modeling the process of elaborating a plan is to establish the limits for the opportunities of the existing economic mechanism to increase production efficiency and to provide sound recommendations on improving the planning and incentive system.

A Model for Elaborating a Sectorial Plan

The compiling of a sector plan can be formalized in the form of a nonlinear problem of mathematical programming which represents an extended form of a game with nonopposing interests [5]. Let us introduce the following symbols: j -- the enterprise index; n_j -- the vector of normal indicators set for the enterprise j; r_j -- the vector of resources allocated to enterprise j; z_j -- the vector of planning indicators set for enterprise j; x_j -- the vector of product output in physical units; $y_j=(n_j r_j z_j)$ -- the aggregate vector of controlling effects of the sector determining the planning situation; $t_j(x_j; y_j)$ -- the vector of the main technical and economic indicators for the operation of enterprise j and determined by the planning situation; $c_j(t_j)$ -- the effectiveness function of enterprise j; $T(y_j)$ -- the set of variations for enterprise operations adopted according to technological and economic considerations.

In accord with the principle adopted by us for describing enterprise operations, the vector $t_j(x_j; y_j)$ is the solution of the problem

$$c_j(t) \to \max,$$
$$x_j \in X_j(z_j, r_j),$$
$$t_j \in T_j(y_j),$$

where $X_j(z_j, r_j)$ -- the set of production programs which are technically feasible with the set plan z_j and the corresponding resource support r_j.

It is possible to incorporate the most diverse conditions in the description of the set $T(x_j; y_j)$. Let us list the most important of these.

1. For ensuring the required proportions between the effective use of labor resources and wages, the sector sets normative constraints from above on the ratio of the growth rate of average wages and labor productivity of the enterprise employees.

2. In the aim of increasing the efficient use of the labor resources, a normed constraint is introduced from below on the ratio of the growth rate of labor productivity and the amount of normative net product. In this manner, it is possible to norm the proportional amount of the increase in production coming from increased labor productivity in the total increase of product output.

3. Under the conditions of planning practices from the achieved level, the enterprise itself may not be interested in the complete disclosure of its production potential. In describing the set $T(y_j)$, this is reflected as a constraint from above on the percentage of plan overfulfillment for the output of gross product and for the sales volume.

The proposed procedure for constructing a sectorial plan using models takes into account the existing planning practices and consists in the following.

Having obtained the plan quota for the output of the most important product types and for the main technical and economic indicators (gross output, sales volume, labor productivity and so forth), the sectorial planning body first allocates the product range plan between the enterprises. Here it proceeds from the existing specialization of production, if possible without disrupting the structure of the previous year's plan.

For the selected product range plan they figure the necessary material and financial support. After this the sector still has at its disposal centralized resources which are allocated between the enterprises in approximately the same proportion as in the previous year. In this manner the enterprises establish a certain surplus of exogenic resources. The amount of endogenic resources at the enterprises also, as a rule, with a certain surplus meets the requirements for carrying out the product range plan.

The enterprise itself determines the areas for employing the additional resources. Basically these go into producing "other" products which are not included in the sector product range plan and the proportional amount of these products at the enterprises is rather large.

Managing the range of "other" products provides the enterprise with significant freedom to maneuver upon achieving the volume production indicators set in the plan. Examples are known where the overfulfillment of the sales plan has been accompanied by the underproduction of the most important types of products set in the range.

Having set the plans for the product range z_j and having established the values of the norms y_j, the sectorial planning body thereby formulates the initial approximation of the planning situation and the set of realizable plans $X_j(z_j, r_j)$ and $T_j(y_j)$. In knowing the effectiveness functions and the models of the enterprises, it can calculate optimum responses $c_j(t_j(x_j; y_j)$ to the controlling action. Here the work of the entire sector is played through in models. If the expected sectorial indicators keep within the plan quotas, the process can be concluded. Otherwise the sectorial plan body changes the values of the norms y_j and hence the effectiveness functions of the enterprises and the set $T_j(y_j)$. After this, enterprise operations are again modeled. This procedure is repeated until satisfactory values for the expected sectorial indicators are obtained.

If the manipulating of just the norms does not provide a satisfactory result, then one turns to a stronger means of effect, the product range plan. The vectors of z_j and correspondingly the set $X_j(z_j, r_j)$ are revised. For each variation of the product range plan the procedure is repeated of a search for the most effective set of norms and so forth until the required sectorial indicators are obtained or the infeasibility of the sector plan is shown.

The described scheme of calculations can naturally be interpreted as an hierarchical game with noncontradictory interests. A business game would be the most adequate realization of such a procedure. However, one must consider the difficulties of its actual execution, when a significant number of skilled experts would have to be involved in it.

The following circumstance makes it possible to substantially simplify the calculation procedure and bring it into accord with the real capabilities of the sectorial planning bodies. As experiments with a model have shown, the existing system of economic incentives has a rather weak influence on the economic policy of the enterprises. The possibilities for varying the parameters of enterprise optimum responses within a practically acceptable range of change in the norms with a fixed product range plan are usually slight. The set of product range plans which can be set for the enterprise is also completely viewable. Consequently, for each enterprise it is possible to calculate the assumed optimum responses to the controlling actions of the center $\hat{x}_j^k(y_j^k)$ and the corresponding sets of technical and economic indicators $t_j^k(x_j^k; y_j^k)$, where k -- the index of the variation of action.

With such an approach the sector-level model is formalized in the form of a problem of integer linear programming

$$\sum_j \sum_k d_j^k \delta_j^k \to \max, \tag{2}$$

$$\sum_j \sum_k a_j^k \delta_j^k \geq z, \tag{3}$$

$$\sum_j \sum_k f_j^k \delta_j^k \geq t, \tag{4}$$

$$\sum_j \sum_k r_j^k \delta_j^k \leq R, \tag{5}$$

$$\delta_j^k = 0 \text{ or } 1, \quad \sum_k \delta_j^k = 1 \quad \text{for all j,} \tag{6}$$

where d_j^k -- the contribution of enterprise j to the sectorial effectiveness criterion with variation k of the controlling action. The integer variable δ_j^k assumes the value of one only for that variation k which should be employed at enterprise j. Vectors z, t and R describe, respectively, the sectorial planning quotas for the main product types (positions) of the product range, for the technical and economic indicators as well as the sectorial limits for the major resources. The aggregated values of the technical and economic indicators can be obtained not only by the simple adding up for the enterprises but also as average weighted ones. In certain instances it is advisable to incorporate constraints for the minimal values of the various technical and economic indicators for the enterprises.

By the selection of the different control actions it is possible, in essence, to have a point approximation of the sector's effectiveness function in the set of optimum enterprise responses to the various control actions. The quality of approximation from the viewpoint of the solving of an optimum problem is determined primarily not by the number of variations but rather by their correct choice. It is essential to form the most characteristic variations which provide maximum information on changes in the responses of the enterprises to the controlling actions. The problem which arises here of choosing the variations is close in sense to the main problem of planning the experiment where a limited number of points in the space of the factors must be chosen in order to obtain maximum information on the behavior of the investigated object.

An effective algorithm for solving the problem (2)-(6) has been described in [6]. Here it must be pointed out that the number of constraints can include not only the plan indicators. The search for a coordinated plan is always, either recognized or not, a multicriterial problem. When necessary, it is possible to employ various man-machine procedures for multicriterial optimization.

The described planning scheme employing a bank of enterprise simulation models was the starting point for constructing coordinated plans in the sectors of petrochemical machine building for 1984 and 1985. In the course of operating the informational and algorithmic support for the calculations of an annual plan, virtually all the components of the complex underwent significant changes. Adaptation to real planning conditions in the subsector required an inevitable revising of many premises and technical solutions. In particular,

it was possible and necessary to simplify the models of the individual enterprises in the aim of their viewability and this increased the effectiveness of the optimization calculations. In addition, it was disclosed that after virtually every calculation of a plan variation, it was necessary to incorporate changes in the informational data base and carry out an additional retrospective analysis for ascertaining the reasons for a discrepancy between the planning and actual indicators of enterprise operations. The rapid change of products as well as changes in prices, labor intensiveness coefficients and other indicators required a substantial revising of the data base structure.

As a whole, it is possible to conclude that the viability of the range of models for constructing coordinated sectorial plans is provided with the fullest possible consideration of the actual conditions of enterprise operations and interests as well as with the establishing and constant maintaining of the appropriate data base.

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DEVELOPMENT OF MATHEMATIC ECONOMICS INSTRUMENTARIUM AT PRESENT STAGE

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[Text] Mathematical economics instrumentarium has been developing stage-by-stage. It has been improved, become richer and has taken life. It is extremely important that the instrumentarium keep pace with the times, the contemporary and correspond to the general development of science and technology and to the tasks posed for economic science by the 27th CPSU Congress.

The mathematical economics area is presently living through a difficult period and has reached a sort of crossroads. Obviously a major, tumultuous, interesting and glorious stage of its development is coming to an end. A great deal has been achieved. I will not speak about the achievements and the difficulties. This is a matter of separate review. At present, we are on the threshold of a qualitatively different, new stage. Undoubtedly, its buds are already here. The question is to spot them and not to take the chaff as something substantial. It is also important to correctly understand the role and place of the mathematical economics instrumentarium on the general front of economic science and management practice. The founders of the mathematical economics school V.S. Nemchinov, V.V. Novozhilov and L.V. Kantorovich were for us models of analysis of economic problems. They must be followed.

In the current article we have taken up only certain aspects in the further development of the mathematical economics instrumentarium.

1. On the Role and Place of the Mathematical Economics Instrumentarium in Economic Science

All of us, the representatives of the mathematical economics school, have struggled to make mathematical methods and models, a mathematical approach and the mathematical style of thinking part of the arsenal of economic science as an essential element. We have dreamed that this means would become an ordinary, customary and traditional tool of all specialties of economists. We had said that a modern economist should without fail master mathematics and

computers, otherwise he would not be modern. At present, when much water has already gone over the dam, there still are zealots who feel that the mathematical method is the main method of research in economics. Economic research is many-sided. It employs the most diverse instrumentarium. Mathematical economics methods and models are only one tool among a number of others. This is clearly correct. But at present other zealots have drawn incorrect conclusions from this correct idea. In particular they reason approximately as follows. In terms of modern economic science it is incorrect or even absurd to speak about economics with the employment of mathematics or without the employment of mathematics just as, for example, it makes no sense to speak about biology with a microscope and without a microscope. Once a science is modern it means it includes mathematics and includes the microscope. From this there follows the supposedly "ironclad" conclusion that there is no need for a special mathematical economics school in economic science. All economic science, since it is modern, is mathematical economics. The age when a special mathematical economics area was needed has ended. This school as such has outlived itself and has been dissolved in the science as a whole.

That is both the case and not the case. In actuality, the stage when mathematical economics was taken up for solving virtually all problems in economic science has ended. At present, everyone realizes that a mathematical model is not a panacea for all misfortunes. But at the same time a new stage has commenced which, possibly, is calmer and less pretentious but nevertheless an important stage in the development of mathematical economics methods as an instrumentarium, and precisely an instrumentarium of economic science. Modern economic science is an instrumental one. It is inconceivable without diverse means, including technical ones, based on the entire arsenal of modern science, including naturally, mathematics and computers. Here by an instrumentarium one understands the mathematical economics methods and models, the computer programs, the computers themselves, computer facilities as well as other means for handling information (television, video tape recorders) and so forth, and so forth employed in economic research.

We feel that the specialty in the VUZes "Economic Cybernetics" and, respectively, the VAK [Higher Certification Commission] specialty 08.00.13 "The Employment of Mathematical Methods in the Economy" are presently assuming a somewhat different cast. Possibly it is worth giving some thought so that they would more clearly differentiate the development of the instrumentarium itself and its application for resolving specific problems of economic science. These are different things. It is one thing when one is a specialist in jogging and another thing if one is a specialist in treating weight problems by jogging. The existing practice of giving courses in economic cybernetics and the defense of dissertations in the specialty 08.00.13 often encourages something midway between the development of mathematical economics methods and their application. As a consequence, both questions often end up not in the best way. This applies particularly to the dissertations. The weakness of a model is justified by the value of the numerical results and the not very convincing practical conclusions are explained by the increased attention paid to the model part. If a dissertation is devoted to the employment of the instrumentarium, then the academic degree must be awarded for the specific solving of the appropriate

economic problem and not for the fact that this problem has been modeled or formalized. The latter is the best way to discredit the mathematical economics method of research.

The instrumentarium and specific problems of economic science are, as it were, the two ends of a single piece. They develop in the process of a reciprocal influence and reciprocally enrich one another. The falling behind or rushing ahead leads to dissonance. And it is very bad when a gap between the two arises. For example, an excessive involvement with abstract formalistic constructs or, conversely, naked impericism.

Mathematical economics is that portion of the mathematical economics instrumentarium which, along with the methods of optimization, mathematical statistics and others, lie at its base. Mathematicians which are accustomed to strictness and preciseness of definitions, arguments and conclusions, from time to time have attempted to provide their own mathematical definition for the concept of "economics," "national economy," "production," "production methods" and so forth. These attempts have been beneficial and have provided an impetus for further research when the definition corresponded to the spirit of the times and echoed vital problems which concerned the minds of research economists.

Due to the demands of strictness, the mathematical models of the economy -- the subject of mathematical economics -- are always limited, narrow and at times primitive, and they reflect only certain aspects of a phenomenon, partially considering or even completely not considering other ones. On the other hand these are actually strict mathematical concepts which can be examined using the powerful and constantly improvable arsenal of mathematical methods. As a result of mathematical analysis, concepts can be discovered which enrich economic theory and precisely economic and not mathematical. Mathematical economics, its approach and methods show how mathematics helps to draw qualitative conclusions on economic processes and phenomena. Let me emphasize that these are qualitative, as up to now there still are views about mathematics in economics as a purely computational tool which make it easier for the economist to carry out extensive calculations.

Let us turn to example. Let us take such a concept as the optimum plan. In a mathematical model this is determined simply and comprehensibly. It is much more complicated in a meaningful economic theory. An optimum plan in optimum planning models developed in the works of L.V. Kantorovich and, respectively, the Pareto optimum arising in the theory of prosperity are concepts which, on the one hand, are very simple, and on the other, profound and extensive. In analyzing the mathematical model of an optimum plan, one inevitably and quickly reaches the conclusion on the unity of the plan and prices, the plan and economic norms (capital investment effectiveness, the return on resources, amortization and so forth). But economic life is infinitely richer than a model. A real plan, real prices and real norms are not mathematical abstractions which are comparatively easy to analyze. Behind them stand social relationships and economic interests which in a model of the optimum plan model type remain "out of the picture." Time has shown that an optimization model for planning was a powerful tool in developing an understanding of the significant range of economic phenomena. The arsenal of

economic science has been enriched by the concepts of economic equilibrium, the core of the economy as a profound generalization of the Pareto optimum, the optimization or Neumann structure of the economy, the mainline, the golden rule of accumulation and others, to a significant degree due to mathematical economics. Each of these as it were opens up a new window, a new viewpoint, a new instrument through which it is possible to view economic reality. Naturally, through such a new window it is possible to see what cannot be seen by another method. For this reason it is quite justified to call mathematical economics a science which provides the tools for understanding economic reality. In our nation the research in this area has been sound and this is largely due to a number of first-rate scientists, primarily L.V. Kantorovich. However, in recent years the uniqueness of Soviet works in mathematical economics has begun to lose its luster. The obtained results are of a motley sort and one does not feel the directing, organizing strength. Few corresponding specialists are being trained. We feel that at present there are good grounds for consolidating forces in the nation on a basis of two interrelated areas of research.

The first is the models of the interaction of different economic mechanisms. Obviously this will be the high road of further developing mathematical economics. In actuality the time for analyzing purely economic mechanisms is passing. The model of an optimum plan or the economy of prosperity has been examined in depth and breadth. The same thing can be said about the mechanism of a market-type economic equilibrium (the Arrow-Debre model and its generalization). Models are appearing which examine the mechanisms of the direct in-kind distribution of products, but they themselves, in a pure form, are not very interesting due to the limited range of situations where they can be employed. There are models of contractual relations, models of management employing a change in the wage systems and so forth. It is possible to imagine the appearance of some interesting economic mechanism for which the use of a mathematical system will be beneficial. But these are all particulars. Mixed models are fundamentally new. The interaction of different mechanisms is the central object of research. In life one certainly observes mixed mechanisms. There is a rather long list of them. The question over which there has been much jousting is the combination of centralized and decentralized principles in modern economics (both socialist and capitalist). It is impossible to contain the entire diversity of economic life within a plan. Unplanned production, exchange, distribution and redistribution -- by what laws and with the aid of what mechanisms should these be carried out? We observe an interaction and symbiosis of different mechanisms at every step. We purchase certain products from wages, others we gain in the form of in-kind distribution (medicine, education) and still others from something midway between the first two forms (housing). At the same time, there are several types of prices (state retail, cooperative, kolkhoz market prices, prices in the departmental network and so forth). In the production sphere, along with price lists there are also contractual prices, surcharges and rebates. Certain types of prices can be flexible and change frequently while others, conversely, are stable. The same thing can occur in terms of economic, financial and planning norms. For this reason no "pure" economic mechanisms can be the ideal or best. A certain combination of different mechanisms can be the best. But this is a new positing of the question. It must be analyzed and examined on a model level within the context of mathematical economics.

and examined on a model level within the context of mathematical economics. The starts of this research can be found both in our country and in the West.

The second area is mathematical models of scientific and technical progress (STP). Unfortunately, a lag must be noted in this area. The mathematical modelers have not learned to adequately describe scientific and technical progress in the economy. In an economic system at the intensive stage of its development, fundamentally different phenomena, characteristics, indicators and so forth arise than in the extensive one. For example, the indicators of the technical level, quality, consumer properties and so forth. For products, production processes, work places, economic organizations as a whole and so forth. An intensive economy can develop rapidly and produce a rapid pace by improving quality, the technical level and consumer properties, without changing the quantitative, volumetric indices in so doing. True technical progress is characterized by a fall in expenditures per unit of consumer effect. Another important property of it is the constant rise of new products as well as new demands. We have merely to turn to electronics where STP has been particularly rapid. The time is approaching when the main toys for children will be electronic. And since in the process of playing there occur indoctrination, the shaping of views, needs and, possibly even an ideological effect, the corresponding concept of education can and must be included in the electronic games. A third property of an intensive economy with accelerated STP is in the domination of the process of change in the production methods over stationary production. Here the process of introducing innovations becomes determining and requiring its own organizational structure, own mechanisms, indicators and so forth. All the listed properties have not been adequately reflected in the mathematical models of the economy. The problem is a difficult one. This can be seen even from the fact that a mathematical description of the comparatively simple process of introducing a technical innovation involves a diverse mathematical system. This includes both optimization dynamic models of the economy, the models of the spread of an epidemic (rumors), as well as models of the "hunter-victim" type, evolution (natural selection) and even diffusion.

The forces exist for developments in the designated two areas. They are concentrated in Moscow, Novosibirsk, Vilnius, Leningrad and Kiev. The agitation and organizational efforts are required for their consolidation.

2. Machine (Computer) Modeling of the Mechanisms of Planning and Managing Economic Activity

Over the last two decades there has been a qualitative change in the situation in the production and use of computer equipment. Computers have come closer to man and have become a marked element of his daily surroundings. On the threshold lies an era of universal computerization and the dissemination of unique computer thought. The latter can be understood as a continuation of the traditional method of thinking in which logical arguments, mental model constructions and mental experiments prevail with each step being monitored by conscience. The incorporation of the computer in the thinking process leads to a situation where individual stages of this process are not monitored by conscience. They are accepted as due, on belief. At present, the mistrust of the old bookkeeper who checks the work of an electronic calculator on an

abacus is viewed as a curiosity but mathematicians quite seriously are discussing the question of the reliability of the proof of a complex theorem obtained by a computer method. A computer experiment is beginning to develop actively and this is gaining rights of citizenship in an ever-larger number of spheres.

We feel that the economic sphere, as it is termed, has been created for computer modeling and experimentation. The problem is that economic activity can be modeled very conveniently by the "from within" method and not only by the "from without" model. The "from within" method is sometimes called simulation. A computer program simulates the real process, it creates a "similarity" which at times is very superficial and external. Simulation modeling due to its simplicity has recently become widespread in various areas, including in the economy. Its limitation is obvious but the method is universal, convenient to use and has performed well in rough approximate analysis. The "from within" method is similar to simulation. It also consists in copying, only not the external aspect of the described process but rather its inner structure, all its twistings and turnings. The "from within" method thus is very labor-intensive. One must scrupulously describe the elementary acts of economic and management activity and then reduce them to one, to synchronize them and then with equal scrupulousness to describe the interaction and result of carrying out these elementary acts. We feel that in economic science the "from within" modeling method should play the same revolutionary role as at one time was played by the method of describing production and planning activities in the form of an optimization problem of the linear programming type. As for now it is in an embryonic state. In order that the "from within" modeling method be employed widely and effectively, it is essential to work out the corresponding software which would reduce labor intensiveness by many-fold. Ideally, we would like to have a program which would translate a verbal description of one or another process in ordinary Russian into a computer model of this process.

Let us now imagine that such an instrumentarium has been developed. Machine models have been created of different economic processes, production lines, material-technical supply, planning and management on all levels. The facilities have also been developed for the rapid changing of these, the supplementing with new and so forth. This means that the possibility has arisen of machine testing different variations of the economic mechanism and to evaluate any combinations of economic and management measures. Thus, an instrumental basis has been prepared for management (or economic) logic. At present, a great deal is being said about economic logic. This name has been given to one of the fundamentally new phenomena in economic science. Economic logic can be explained by analogy with ordinary formal logic. The latter defines and examines true and false propositions compiled from elementary statements as well as true (and false) methods of deducing certain propositions from others. In economic logic, the measures to improve the economic mechanisms operate as the elementary statements while combinations of these measures are the propositions. For example, full cost accounting and wholesale trade in the means of production are such measures. In their aggregate they form a more complex measure in which, in accord with the rules of economic logic, the initial measures complement and reinforce one another. According to this same logic, full cost accounting with the centralized

allocation of resources using the system of "funds" is not brought together into an effective system. One measure, according to economic logic, contradicts the other. And this is understandable when there are two such measures. And if there are many of them, then the question of their conformity to economic logic is not simple. There must be labor-intensive analysis and a machine model makes it possible to do this, for example, in the following manner. A machine experiment is run with a version of the economic mechanism (a fixed set of measures). Then the experiment with the same data is run with another set of measures obtained from the first substituting, for instance, of one measure. In comparing the results of the experiment, one can conclude which of the variable measures more logically fits with the remaining set. Understandably such manipulations involving the measures can be carried out with any combinations of them and conclusions drawn on the relative value of the most diverse proposals. Economic logic, incidentally, convincingly shows that of value is not any one proposition to improve the economic mechanism but rather, as the mathematicians say, their complete system. At the same time, the experience of introducing individual, possibly in principle very good propositions, to improve management has shown that the current system in a way suppresses or rejects this proposition and it as a result is nullified in full accord with economic logic.

The designated instrumental base of economic logic in actuality is a complex formation which cannot be termed a machine model of the management mechanism or a model of the economy. This is not the model of an economy but a certain tool by which it is possible to test out various models. In speaking about testing it is natural to term this a stand. In any event, such a term has recently begun to be used in discussions, although for now there is no convincing definition of this concept. We feel that a stand should contain at least three parts:

A bank of data files with a developed system of its control;

A bank of models where each model is described uniformly and in a standardized manner; the bank includes a series of models which is sufficiently diverse in terms of the scope of the economic processes in order for one to be able to speak precisely about a stand;

A control system for the stand which possesses a broad range of devices for generating systems of models, for formulating the scenarios and planning economic experiments, for processing their results, for adjustments in the course of fulfillment an so forth.

Naturally, both banks should have a convenient structure, including a hierarchical one, in order that the individual models could be assembled from submodels and the information easily fitted to the appropriate model. For the control system it is essential to develop a language in which one could simply and clearly describe any experiment. In particular, the assignment of carrying out the calculation using the same information for the various models and the comparing of both the results of the calculation as well as, possibly, the models themselves should all be simple. Conversely, with the aid of one model but with different data one should be able to make the calculations and comparative analysis. Possibly it would be wise to formulate and run

separately a file of measures to improve planning and management. Such a file must also be organized hierarchically, since large measures are broken up into small ones and so forth. The system for managing the stand should have the means for assessing a separate measure or aggregate of measures using different criteria and under different conditions. The control system could include optimization algorithms for the forming of the best (in the sense of the established criterion) system of measures which, for example, employ certain methods of a directed exhaustive search. It would also be possible to speak about a bank of questions asked of the system, a bank of testing logs and, finally (with the most developed version of the stand), a knowledge base.

In this last variation the stand, in essence, is an example of a so-called expert system, that is, a program-instrumental complex which contains as essential components: a) the data bank (the base of facts and operational memory) in which is concentrated the "information filling" of the analyzed mathematical economics models and economic measures; b) a knowledge base which would include, in particular, a bank of models and methods, a list of measures to improve the economic mechanism and applied (method-oriented) software; c) a knowledge manager or interpreter which turns to the knowledge base for information for an interpretation (using the logic of conclusions established in it) of the contextual data from the operating storage; d) an assist modulus in accumulating knowledge; e) a modulus of interactive communication with the user. At present, the basic principles have been worked out for the designing of expert systems and there are examples of their practical realization in medicine, geology, engineering, statistics, chemistry and other areas.

Let us mention several of the most important problems in economic science and practice which could be effectively investigated using machine models and experimenting with them.

The elaboration and step-by-step introduction of an integrated concept of the mechanism of economic management. This, as is known, is the number-one problem for the 12th Five-Year Plan. The above-given arguments on economic logic establish the application of machine models to this problem. The idea of an integrated concept has been formulated precisely with the aid of economic logic. One has merely to overlook some seeming detail and the entire project could fail. For example, the normative procedure for the forming of economic incentive funds which has been adopted according to the new management conditions has been supplemented by the setting of volume indicators of these funds from above. When it is a question of an integrated concept of the economic mechanism, one must be certain that the enormous number of departmental regulations, instructions and so forth will conform precisely to the basic principles of the concept, that they will reinforce and develop them and not be an impediment. A machine model of the economic mechanism makes it possible to carry out this work. All of this applies to the process of the stage-by-stage introduction of the integrated concept.

Comparative analysis of the economic mechanisms in the socialist countries in the aim of ascertaining forms and methods of management which are effective under various specific conditions. This problem is natural for examining the economic management measures within the modeling stand.

An analysis and an assessment of the results and areas for further development of the economic experiments being carried out in the nation, including the large-scale ones. A machine model makes it possible to repeat an experiment conducted in real life, to process it according to all the rules as well as run machine experiments which are, so to speak, on the outskirts of the base one.

A methodology and procedure for normative planning and the planning of qualitative indicators. During the 12th Five-Year Plan, this will be a central problem in improving the socialist economic planning system. As is known, there has been a gradual transition from the planning of volume, quantitative indicators to indicators of quality and efficiency, to standards, to relative, proportional indicators. The party and government have set the task of quickly accelerating this transition and to bring about an abrupt change in the planning methodology. Computer models can help substantially in resolving the given problem due to their following properties. Developed, sufficiently complete models constructed by the "from within" method contain submodels of production as well as planning activities and the economic mechanism. Such models are designed to determine the response of an economic organization to planning and other management actions and to one or another version of the economic mechanism. In a planning system based upon the assigning of the product output volumes to executors, the problem of ascertaining the response of the producers was not so acute as this remained on the sidelines. But if the economic organizations are assigned not output volumes but rather norms (efficiency, return on resources, expenditures of production factors, financial and so forth), then it is extremely important for the planning body to know how the corresponding system of norms and their specific values effect the actual production activities. For the planning bodies this is a fundamentally different problem and a definite instrumentarium is required for solving it. The designated stand for modeling the management mechanisms is completely suitable for working out such an instrumentarium.

The elaboration and introduction of management techniques on all levels of decision-taking and supervising of their observance. The concept of management techniques has still not been sufficiently settled. Unfortunately, there are no fundamental works of a ground-breaking sort. But in one or another context the concept of management techniques is employed. The description of the very subject -- the techniques of management activity -- is an occupation which evokes no enthusiasm either among the researcher or the reader. The appropriate language and tool of analysis is needed. It seems that models of economic management constructed by the "from within" method could become such a tool.

We feel that the problem of management techniques is a fundamental one for our state. Around 2-score million persons are employed in management. It can be said confidently that this is the largest profession. Just what it specifically consists in, no one can say. There is the concept of production discipline on the job. In modern production the observance of this is everything: both the quality, the time and general order. But in management the techniques have not been fixed and for this reason it is impossible to observe what does not exist. The losses from this are enormous. The press is

full of examples of red tape, bureaucracy and clearly incorrect decisions but, as is known, in examining the most flagrant facts of mismanagement one will not find the guilty parties. If a large unit has been sent to the wrong destination, if a fine has been paid to the wrong firm, if a plant has been built in the wrong place, if costly equipment has been manufactured according to a plan is unnecessary -- there will be no guilty parties. Each person at his place has seemingly acted reasonably. The solution is to fix and strictly observe the management techniques. When at one time a month-long data was introduced for responding to worker complaints as well as supervision over the fulfillment of these dates, the problem disappeared. This is an example of a slightly organized technique. Recently, inventors as well as lawyers have raised the question of supervising introduction activities. Many proposals for introducing innovations are merely marking time. Or take the problem of shortening the development cycle of a new product and putting it into production. Here the main reserve lies in the sphere of coordination. Scores and hundreds of approvals are needed for resolving introduction questions. In the ministries and departments there still is the practice of "avoiding decision taking and lead an easy life." For this reason the at first glance paradoxical situation arises when management workers who by their very position should assist in introducing reasonable proposals act to the contrary in impeding them as much as possible. These workers are interested in not having any clear management techniques so that it would always be possible to avoid decision taking or at least responsibility for an incorrectly taken decision.

We would point out that the introduction of clear management techniques on all levels is not directly tied to the policy of "tightening down" amid management workers. These are different things. On the contrary, we feel that control over the supervision of these procedures should be sufficiently publicized and comprehensible to the community and then it will be effective.

3. Convenient Presentation of Information for Economic Measurements and Economic Analysis

Any science, including economic, is nourished by facts. On the body of the economy there should be a sufficient number of sensors and these should supply the most diverse information both for the scientific as well as for the practical workers. A specific feature of the system of economic measurements is that this plays an active role in the economy and is a part of it, in contrast to measurements in other spheres. It is correct to consider economic measurements as a component part of the economic mechanism. These should be improved and adjusted along with the economic mechanism, they should not lag behind it and should correspond to it. STP and social policy have been mentioned as the main acceleration factors in the Basic Directions of the Nation's Economic and Social Development for 1986-1990 and for the Period Up to the Year 2000. These are both insufficiently supplied by the existing system of economic measurements.

The problem of measuring STP was mentioned above in the context of mathematical models of STP. A few words on measurements in the social sphere as well as in the sphere of the distribution and redistribution of income and generally the unplanned economy. It is no secret that things here are going

badly. The information collected by the state statistical bodies as well as by the concerned ministries and departments is of a mosaic, fragmentary and unsystematized nature. The situation could be changed in line with the government's decision to establish a statewide system of measurements in the social sphere. Some concern must be given so that from the very outset it be based upon correct ideas which make the system a system. The gathering of information about the social sphere requires a special instrumentarium which in our country is still in a rudimentary state. If samplings and questionnaires on various matters are beginning to gradually come into use, technical devices and various indirect procedures for obtaining information are not employed at all.**

The current article is devoted to the instrumentarium employed in economic science and economic practice. For this reason the question of economic measurements here is raised in the context of that role which the corresponding instrumentarium does or should play in them. This role is fundamental in the problem of providing information in a form convenient for the user. It might be asked just how fundamental is the very problem of providing information in a convenient form? At first glance it seems secondary, technical, without any special importance. This view is widely held. But in fact this is a key problem for understanding the essence of economic questions and for decision-taking. A convenient and comprehensible notion of information is an entire science, an interdisciplinary science requiring the efforts of mathematicians, economists, psychologists and technicians for its development. For example, we are confronted with a series of figures describing the change over time in a certain economic indicator, for instance, national income. This can be provided to the user in scores if not hundreds of ways in the form of charts and bar graphs, in different scales, with differing bases and so forth. How many manipulations can be carried out with this series of figures (calculate percentages, rounding off, dividing up into periods and so forth)? We might consider that these are all sorts of ways of presenting information. But this is nothing more than all sorts of answers to all sorts of questions which can be asked about the given information. To answer the question means to provide information in a form so that it would contain the direct answer to a person's question. Mathematicians say that to formulate a problem successfully in a convenient language is halfway to solving it. Moreover, any mathematical theorem is the conditions of the problem formulated in other terms, in another language. If the language of the conditions and the language of statement are close, then it is said that the theorem is simple or trivial.

For a person making a decision, it is particularly important when he himself saw the solution on the basis of information supplied him or his experience and knowledge and did not receive it in the form of a suggestion. As is known, a person obtains a large portion of information in the form of visual images and this should be considered in the science and art of providing information. Graphic colored displays are becoming a widespread means for this purpose. But the dynamic presentation (showing) of information is still virgin territory, although the equipment already exists for such a demonstration.

We will give the following arguments as a full resume on the possible formation of a science concerned with the convenient presentation of information. An absolute majority of mathematical models and algorithms, computer programs, various formalized procedures and instructions are designed for reworking incoming information into outgoing, where the latter answers, hopefully in a uniform manner, the set question. And precisely a previously set question. A model is formed for resolving it. For example, a linear programming model processes the numerical matrix of coefficients for production methods, the vectors of the constraints and specific function into a solution to the problem, an optimum plan, thereby giving the answer to what plan this is. Certain programs answer the question differently. For example, it would be possible to employ several different programs for image recognition for the same initial information and obtain several different answers. But in any event one or several answers would be obtained to the asked questions. The model and the programs being described in the science concerned with the convenient presentation of information, in terms of their specific function are fundamentally different. They also process the input information into output. But the demands made on the output information are different. The main thing is that the information be convenient for perception and maximally accessible. Packs of two-dimensional and three-dimensional graphics provided to the users of computers are an example of such programs.

At present, computer games have begun to be widespread. A computer game is the combining of traditional type programs which present information: the situation of the game, the solution and so forth in a form convenient for the player. Precisely this second type of program is crucial for the game's popularity (particularly for children). Computer games are already a new, extremely effective means of instruction and instruction in the most diverse subjects. Finally, this, as was pointed out, is also a means of ideological indoctrination. Star Wars is perhaps the most widespread type of computer game in the West. Recently a game appeared there called "Balance of Power" where the player endeavors, using various means, to achieve strategic advantages for the United States in relation to the USSR.

The above-mentioned expert systems apply precisely to that type of instrumentarium which successfully combines the traditional applied programs with the programs for ensuring visibility of the output information and the possibility of varying the form of its presentation depending upon the nuances in the specific focus of the user's questions. With the aid of a well-developed dialogue with the user and relying on the knowledge base and interpreter existing in the expert system, a computer can "understand" precisely what form of the output information is most convenient and accessible for a user in solving one or another problem and then provide this. The effectiveness of the computer system depends crucially upon this.

Situation analysis is a combination of expert systems and games. A person participating in a situation being played out lives in it when he obtains information in a form convenient for himself.

4. The Problem of Introducing Mathematical Economics and Machine Methods Into Planning and Management Practices

This problem has been around for many years. Just as the optimization models and methods were to provide a gigantic effect, while in actuality they were employed sporadically and the savings was, as a rule, the same notorious hypothetical savings which in some evokes a smirk and in others irritation. The situation is possibly a little better, but not much, with the introducing of computer equipment generally into planning and management practices. On the question of the effectiveness of the organizational and economic ASU [automatic control or management system], much has been written but obviously the case could not be otherwise. Such are the laws of introduction. Computer technology in planning and management of the national economy on all levels is a fundamentally new, revolutionary technology. Because of its universality, vast scale, comprehensiveness and revolutionary nature, it cannot be extended instantaneously. Time is required and significant time. Introduction inevitably should go through a series of stages. However paradoxical it may seem, both the mathematical economics methods and computer equipment are far from always ready for mass dissemination in the planning and management sphere. Both are in the stage of experimental testing, in the stage of testing experimental models. Mass distribution commences when these stages are over, when the innovation being introduced has been completely worked out, only then do you take it and introduce it. The individual examples of the successful employment of these prototypes in practice prove nothing. A prototype remains such if there is no normal industrial production for manufacturing the given product, if there are no appropriate standards, a uniform technical policy, a service and support industry and so forth. And for now this does not exist.

At the same time, it must be pointed out that practice is not always ready to employ computer technology. At the same time, its application would mean that every planning and management worker was in a new environment, his workplace would be equipped with different tools and the methods of his personal work and the methods of interaction with colleagues would be different. When there are millions of employees and workplaces, it would be most surprising for each worker to work out the methods and set up his workplace according to an individual plan. But at present, something like this is happening. Every planning, management and administrative organization is solving the problem of introducing computers and the new planning and management methods based upon them in its own manner, according to its own understanding and capabilities. Those computers which could be secured are being employed; the general-purpose software is selected by the programmers following the dictates of their own taste, as a rule, those which they are better acquainted with. The mathematical economics models and applied programs are also employed essentially at random, depending upon the existing ties with the various scientific research organizations. All these activities are similar to the assembly of a home-made motor vehicle by an amateur using randomly available parts from different types of vehicles.

The correctly organized introduction and mass distribution of computer technology in planning and management activities should be based upon a specialized sector organized according to all the rules of modern industrial

production. This sector is conceived of as a small number of self-financing scientific-production associations [NPO]. The aim of such NPO is to design, assemble, deliver and set up at the consumer specialized computer installations for planning and management purposes. These same NPO can provide routine maintenance, support, the training of personnel and the modernizing of the facilities. The essence of the idea is that the computer complex represents an end product, a ready-made tool for work. It is provided "turnkey" to the user with the guarantee of subsequent support and modernization. The computer facilities should be standard and typical with the number of types being comparatively small, running in scores and not thousands or tens of thousands as is the case at present. As for the introduction of computer equipment as a whole and not merely into the planning and management sphere, the picture is approximately analogous. A fundamental solution to the question rests in providing an organization of computer production whereby the computer facility delivered "turnkey" becomes the main form of delivering and utilizing computer facilities.

At the dawn of the development of electronic equipment, they were fond of emphasizing that a computer was universal. Historically, computers began to be effectively employed in the sphere of scientific research. The users were scientific workers who actually needed universal equipment and they in terms of their skills and psychological set were capable of adapting to constant adjustments and to the upgrading of the operated computer devices. In the national economy with the mass employment of computers, such universality is not essential. The consumer who performs his range of production or management operations needs a computer facility, on the one hand, which provides maximum convenience in work and, on the other, best employs the capacity of all the devices comprising it. Seemingly, all of this is apparent and understandable to all. Nevertheless, up to now the elements of computer installations have been planned and produced separately, so to speak "willy-nilly." These included processors, external memories, printers, operations systems, base data control systems and so forth. The only thing done in the correct direction was the so-called base assembly (or base assemblies) for the various makes of computers produced in the nation. The concept of a computer installation as an end product was absent in the planning and production of computer equipment and software.

Close to this is the concept of the automated work station (AWS). The latter, we feel, from the very outset has been viewed as a standard mass product and this is very important. The computer installation is based precisely on the AWS. AWS have become widespread for the employees of a savings bank, for a seller of air tickets, and AWS have been worked out or are being worked out for a designer in machine building production, AWS for the economist-bookkeeper and AWS for a programmer. The scale of the spread of computer technology in one or another sphere can be measured rather well by the number of functioning AWS. Correspondingly, the scale of use of mathematical economics models and methods is measured by the number of skilled AWS of the planning and management worker equipped in accord with modern demands. From this it is clear that for the introduction and extensive dissemination of mathematical economics methods, it is essential to have the mass production of

the corresponding AWS. This could be done by that (still nonexistant) sector which produces (makes up, assembles) the computer installations, for the AWS is an extension of the computer installation, a superstructure over it.

End Result (Product) of Corresponding Sphere of Activity	Sectors and Organizations Carrying Out Given Activity
1. Plans, directives, controlling actions of various types (in corresponding standardized form)	1. Planning bodies, administrative bodies, management and planning subdivisions in economic and other organizations
2. Modern computer techniques for planning and management	2. Planning and management bodies on all levels, scientific research organizations, computer centers, ASU subdivisions, including the main computer centers of the USSR and Union republic gosplans and so forth
3. Production, delivery and servicing of AWS for supporting computer management and planning techniques	3. Absent
4. Production, delivery and servicing of computer installations, in particular those which are the basis of the AWS of the planning and management worker	4. Absent
5. Production of preassembled products for computer installations: a) Components of computer equipment	a) Ministries producing computer equipment (Ministry of Radio Industry, Ministry of Electronics Industry, Ministry of Instrument Building, Automation Equipment and Control Systems [Minpribor], Ministry of Communications Equipment Industry and so forth)
b) Software	b) Software sector which is presently in the stage of organization; leading ministries responsible for the development of software such as Minpribor and Radio Industry

As an illustration, let us take the hypothetical but completely realistic computer installation which is based upon one megamini computer and the local network of personal computers connected to it. The basis of the software is the operational system of the SUBD SPEKTR type and several of the most massive packs of the type for processing texts, tables, the data base and so forth. The superstructure for continuing this computer installation is the aggregate of AWS for the planning section like a section of the USSR or Union republic gosplan, the planning administration of a ministry or the planning section of a large production association. For every Elektronika-85 computer there is a corresponding AWS of the section employee, the planner, administrator, leader, technician and so forth. The equipment of the corresponding AWS includes the applied, problem-oriented software essential for executing planning and management techniques which have been carefully worked out according to modern rules.

Here there is one key question. The technology realized with the aid of the AWS is also monitored automatically on the basis of the same AWS. For this reason the question of observing production discipline shifts to a different plane. The problem of employing or not employing optimization models and methods in the various stages of elaborating a plan also shifts to this plane. If according to the work methods such employment is required, then the question rests on observing production discipline and no more than this.

The over-all picture of introducing computer technology into the planning and management sphere can be represented in the form of the following diagram (see the table). In this the first line relates to the end product of the planning and management system and each subsequent one indicates products which must be manufactured in order to ensure the production designated in the line above it.

From the table it can be seen (lines 3 and 4) that in the current planning and management system, the organizing of the instrumental support has two enormous gaps. Since this work should somehow be done, the institutions designated in line 2 are forced to be concerned with an extraneous manner. By hand and within their discretion and capability they make up from hardware and software components (line 5) the necessary instrumentarium and they themselves service and upgrade this. The establishing of organizations which provide the production of the AWS and computer installations (lines 4, 5) can be carried out by a regrouping of forces already employed in the computer spheres.

* * *

The decisions of the 27th CPSU Congress focus us on maximum employment of the achievements of scientific and technical progress not only in social production but also in scientific research, including an analysis of the development problems of economic theory and the improving of principles for taking economic decisions. In turn, this requires a major rethinking of the place of the mathematical economics instrumentarium in the system of economic sciences and its role in carrying out the problems confronting it.

The present article has touched only on certain of the problems in the development of the mathematical economics instrumentarium and its employment

in theoretical research and practical developments. Here there is much to be done and this requires a consolidating of efforts by specialists from different areas.

FOOTNOTES

* The article has been written as a point of departure for discussion. In publishing the given article, the editors invite those desiring to participate in a discussion on the theoretical and applied problems in the development of the mathematical economics instrumentarium in the widened interpretation which the author has given to this term. The discussion is to be completed by an editorial Round Table.

** For example, the popularity of television programs can be estimated from fluctuations in the load in the power network.

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ORGANIZATION, PLANNING AND COORDINATION

REORGANIZATION OF SECTORIAL SCIENCE, ENTERPRISES

Editorial Comment

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 4

[Article under the rubric "The Problem Close Up": "Readjustment: Tasks, Opinions, Experience"]

[Text] To manage the acceleration of scientific and technical progress means to close up all the units, through which an innovation covers its path from the idea to the machine. Thus the first necessity--to stimulate the work of sectorial scientific research institutes--and, hence, the need for a certain "breeding" of these industrial research and design collectives arise. One also cannot manage without the readjustment of the interrelations of the producer enterprises with the users of their products. The need for the orientation of producers toward the meeting of specific production needs of the users and the making of the material well-being of suppliers directly dependent on the degree of satisfaction of these needs arose here. The "degree of freedom" of their economic activity and their independence should be determined by this. Finally, it is necessary to increase the speed of passage of engineering developments. In particular, temporary scientific collectives, within which specialists from various subdivisions become subordinate to the common management of a specific project, contribute to the success here. In this case the situation improves radically. The outlines of the urgent readjustment, which makes it possible to create a unified and controllable system of the updating of equipment and technology--a reliable catalyst of scientific and technical progress--are thus coming to light.

Sectorial Scientific Research Institutes

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 June 86 p 4

[Article by V. Vashchenko, chief of a main administration of the State Committee for Science and Technology, and N. Obraztsov, deputy chief of a main administration of the State Committee for Science and Technology: "Sectorial Scientific Research Institutes. How Are They to Be Evaluated?"]

[Text] The analysis of the problems, which face the national economy and all its sectors, shows that it is impossible to solve the most important

scientific and technical problems in the old way, by using only the already established scientific organizational forms. New approaches to the integration of science and production are needed.

The decree of the CPSU Central Committee and the USSR Council of Ministers on the organization of the first MNTK's--interbranch scientific technical complexes--was adopted in December of last year. Primary attention and priority material and technical supply are being guaranteed and all the necessary financial resources are being allocated to these organizations, in which a large potential for the solution of the most important problems is concentrated.

Today the main research organizations are the next stage, if it can be expressed that way, in the hierarchy of "organizational values." All other sectorial scientific research institutes should cease independent (in the legal sense) existence and become a part of scientific production or production associations. True, let us stipulate, what has been said does not at all mean that the main organization is "more predominant" than the scientific research institute within some scientific production association.

As to the scientific research institutes, which are transferred to scientific production associations, production associations, or even individual enterprises, their basic task is the scientific and technical support and following of the technological cycle. We would like to make immediately the following remark. If we need interbranch scientific technical complexes for the rapid attainment of the most advanced scientific and technical levels and here for the present we cannot calculate completely the future economic impact, in the sphere of series production, in the sphere of plant science, and wherever scientific and engineering thought will come into immediate contact with specific problems, which require rapid solution, the state has the right to expect a large and rapid practical return. Scientists and research engineers, who have become members of production collectives, can and should suggest what it is necessary to do for the radical improvement of technological processes and the sharp increase of labor productivity. Incidentally, the strengthening of the plant sector of science in passing also makes it possible to solve another important problem--to increase the activeness of efficiency experts and inventors. The analysis of both our and foreign experience shows that a competent worker, who is at the source of an engineering development of any complexity, can improve it, can improve individual units of the technological process, and can rationalize his own workplace. While the staff members of the plant research laboratory or institute will help him in this matter.

What we have spoken about above is probably the ideal organizational arrangement: interbranch scientific technical complexes--main organizations--enterprises which have been reinforced by scientific research subdivisions. But, unfortunately, in many cases we do not know what one research collective or another is capable of, what resources it has, and the solution of what problems it is possible to assign to it.

Sectorial institutes for many years developed, so to speak, in departmental isolation. And now, when an important interdepartmental problem--the

overwhelming majority at present are such--faces us, at times we simply do not know what we have for its solution.

In order to put an end to such an obviously abnormal situation, it seems, it is necessary to begin with what any manager begins--with the calculation of his prosperity. But in practice it is a question of a kind of certification of the scientific, technical, and personnel potential of each scientific research institute. The draft of the corresponding document has already been drawn up. The certification of scientific research institutes, in our opinion, can also become a new kind of lever for the increase of the efficiency of their activity. Imagine that, say, every 5 years the collective of a scientific research institute should win the right to its existence. In other words, the developments of scientific research institutes will be financed only if the certificate, about which we spoke above, exists. While it--a kind of right to life of the research collective--will itself be renewed before the start of each five-year plan.

But a tricky question, of course, might immediately arise for the reader: But who are the judges? Who will determine: the given sectorial scientific research institute is to live or it is necessary to close it or to transform it due to the fact that during the preceding 5 years, if you follow our point of view, it worked inefficiently?

First of all, in order to settle this important question, it is necessary to strengthen the functions of the State Committee for Science and Technology as a state monitoring organ. In other words, the USSR State Committee for Science and Technology must be granted the right to eliminate fruitless departmental scientific institutions, taking into consideration only state necessity, and not whether the executives of the corresponding ministries want this or not.

Let us stipulate that now the State Committee for Science and Technology has such a right, but it is worded in such a way that it can be implemented only with the consent of the ministry. You can probably recall more than one publication in the central press about several sectorial scientific research institutes, all the work of which consisted in the "devouring" of millions of state rubles and in the drawing up of reports which no one needs. It seems that it is time for us to realize a simple idea: research collectives, just as everything in nature, originate, develop, and, in the end, "exhaust" the idea which brought them into being. But this means that the moment, when it is necessary to face the bitter truth and to make a fundamental decision, inevitably comes.

Of course, we would like to be understood correctly. It is not at all a question of the "sword of Damocles" over the heads of the people who work in sectorial science. We are speaking about something else--about the flexibility of organizational structures, about the switching of the creative forces of people and the financial resources of the state over to the solution of urgent problems and to the increase of the viability of scientific subdivisions, perhaps in the same ministry, in which a useless institute will be eliminated. And, of course, the right to give a similar--weighed,

scientifically sound, and objective--decision should be granted to an extrasectorial state organ.

The improvement of the network of scientific institutions, of course, is inseparable from the timely obtaining of the necessary information and from its factual support. It is necessary to revise the forms of reporting of the Central Statistical Administration, in accordance with which the activity of scientific research institutions is evaluated today. They should enable us to see the main thing--the influence of scientific research institutes on the technical level of one sector or another of the national economy. In short, with the aid of this information we are obliged to evaluate objectively the state of affairs over the entire chain "from the idea to the machine."

The formation of the optimum network of scientific research institutions, of course, is not an end in itself, but only a means of the increase of the level of sectorial science and the proper organization of research and development. It is natural that today unsolved problems exist here.

Here we would like to single out the main one--the isolation of sectorial science. There is no strong fundamental connection either between the scientific research institutes of individual ministries or between them as a whole and the research institutions of the USSR Academy of Sciences and the higher school. We evaluated the progress of the development of individual scientific directions and found that at times they duplicate each other...five times over! And the most regrettable thing is that the performers not only are not competing with each other, but even do not know about the research which is being conducted by other groups. You understand yourself that this is not the situation, when two strong scientific collectives, which are well aware of the possibilities of each other, are working on the same research theme, while as a result of such creative competition the best development wins the right to live.

In order to put an end to this departmental isolation, it is necessary first of all already at the stage of the planning of major developments to organize their state appraisal. In other words, to determine not only their national economic significance, but the addresses of the performers and to evaluate the possibility of the fulfillment of this work by one scientific research collective or another.

So that the opinion of the experts would be an objective and the only correct one, it is necessary that exhaustive information from the unified data bank on the research and development, which have been and are being conducted in the country, on patents and inventions, and on similar research and development, which are being conducted in the world, would be at their disposal.

It seems that the selection of experts is not too difficult a task. First, a mechanism of such evaluation has existed for a long time now in the State Committee for Science and Technology--this is its scientific councils. Then, do not forget that in our country there is a headquarters of science--the academy, the specialists of which are quite capable of determining the scientific, technical, and creative potential of one sectorial scientific research institute or another.

Second, departmental isolation to a significant degree can be overcome by means of the sharp increase of the level of the main research organizations of the sector, the stimulation of the work of their expert councils, and the effective pursuit of the unified scientific and technical policy. Of course, the work of the expert councils of ministries and departments must be performed under the supervision of the State Committee for Science and Technology in order to detect and support in time the "embryos" of what is new, which are extremely necessary to the country, but, perhaps, do not blend with the immediate themes of sectorial research.

And, finally, the experts should be independent without fail, that is, the interests of the departments, in which they receive their wage, should not prevail over their conclusions. It seems that the materials of the precongress discussion on the need for the diversion of a portion of the runoff of northern rivers to the south is vivid evidence of the dependence of the opinions of experts, moreover, entirely qualified people, on the interests of the organizations, which they are defending.

We are convinced that the improvement of the network of scientific research institutions of the country is one of the important levers, by means of which we can accelerate scientific and technical progress. But another thing is also just as true--all these organizational structures will become viable, if competent people, who have received the necessary training and have gone through careful selection, people, who are capable of seeing a future scientific and technical problem, of estimating its importance for the national economy, and, of course, of doing everything so that it would be solved in the optimum time and with the least expenditures, manage each unit of them.

Avoid Equalization of Enterprises

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 June 86 pp 4-5

[Interview with Corresponding Member of the USSR Academy of Sciences Valeriy Leonidovich Makarov, director of the Central Institute of Economics and Mathematics of the USSR Academy of Sciences, by A. Lepikhov: "The Equalization of Enterprises. How Is One to Avoid It? The Point of View of Corresponding Member of the USSR Academy of Sciences V. Makarov, Director of the Central Institute of Economics and Mathematics of the USSR Academy of Sciences"; date, place, and occasion not given]

[Text] [Question] Valeriy Leonidovich! I would like to begin our conversation with a question about the status of enterprises. Today it is practically the same for them. But if you think about it, enterprises in some way are similar to people. Each of them, like a person, has its own history, its own character, its own reputation....

[Answer] Since you have resorted to such a comparison, I will continue it. We all have a different education, hold some positions or others, and bear individual responsibility for the job assigned to us. In other words, the social status of people is not identical. But if you speak about enterprises,

equalization, for the most part, reigns to this day in their rights, duties, and responsibilities. But back at the June conference in the CPSU Central Committee on questions of the acceleration of scientific and technical progress it was indicated that it is necessary to give special privileges to the collectives, which produce the best products and are successfully competing on the world market with the leading firms, first of all they "should have at their disposal more assets for production and social development and for the remuneration of labor."

For the present the leading enterprises have to prove these obvious, it would seem, things. Moreover, the more personal authority the manager of the collective has, the more likely success is.

The Ivanovo Machine Tool Building Association, which the entire country knows today, obtained additional rights in the area of the simplification of the drawing up of design and technological documents and the procedure of their coordination with numerous instances owing to the irrepressible energy and authority of its director. There is another example. The Institute of Nuclear Physics at the Novosibirsk Scientific Center--the developer of fundamentally new colliding-beam accelerators--received at one time a permit for the commercial production of accelerators and the use of a portion of the assets from their sale for its internal needs. But it received this permit--I believe that this is also no secret for you--only because the Institute of Nuclear Physics of the Siberian Department of the USSR Academy of Sciences is an outstanding research collective, which has enormous prestige and earned special confidence.

[Question] By your response you are returning to the time, when the spontaneous movement of the most energetic and resourceful managers of our production and scientific collectives began to acquire the form which is known today as the large-scale economic experiment....

[Answer] Of course. But consider, what does the experiment in the economy signify in reality? Nothing other than the giving of a particular, special status, which differs from other statuses, to an object or to an entire group of them. Let us take, for example, the changeover of the AvtoVAZ Production Association and the Sumy Machine Building Production Association imeni M.V. Frunze to complete cost accounting. A special status was thereby conferred on these collectives. Namely, they spend a portion of the profit at their own discretion, form the economic stimulation funds and development fund from the gross revenue and profit, but carry out renovation and retooling without the attraction of state assets. In other words, such associations have been placed under the conditions of self-development and self-financing. It is natural that "vital success" in this case depends only on themselves. It is already possible to speak about the first results. I will cite just one example. The Sumy machine builders last year succeeded in boosting their productivity by 13 percent and in increasing the amount of profits by 32 percent. In the very near future all the enterprises of the USSR Ministry of Chemical and Petrochemical Machine Building [as published], as well as several tens of enterprises of other sectors are changing over to the new methods of management.

But now let us ask ourselves a question: What is the status of complete cost accounting for the state? This is one of the most powerful means of developing the economic initiative of labor collectives and their socialist enterprise.

[Question] For the solution of what economic and organizational problems is it necessary to determine and introduce the statuses of enterprises?

[Answer] Take, for example, such a fundamental problem as the increase of the role of the consumer in determining the range, quality, and price of the products being produced. Today in the settlement of these questions, unfortunately, the role of the producer is unjustifiably great. This became a reality, in spite of the fact that the interests of the consumer are taken into account to a greater degree than those of the producer in national economic planning, in the state system of the certification of products, and in the system of pricing. Apparently, this is insufficient. It is necessary to create such conditions so that the consumer could defend his interests not only through state organs, but also directly. The means to this is the introduction of the corresponding status or even a system of them for consuming enterprises.

Such a status could form after the practical realization of several conditions. The first of them is the granting of the right to organize above-plan production. If an enterprise has underutilized production capacities and reserves in the use of manpower, raw materials, and materials, these "surpluses" should be put to use without fail. It is necessary to grant the labor collective the right to produce any product it wants to and to remove it from production at its own discretion. It is natural that such above-plan output cannot then be included for the enterprise in the plan without its consent.

It is possible to realize the idea of above-plan production in different ways. Its share in the total output is easily regulated and controlled by the state. For light industry, services, and the processing of agricultural raw materials this share can be very large; but, say, in the sectors of heavy machine building it is most likely negligible.

Here it is necessary to permit wholesale trade in products, including those which are now centrally allocated, without multiple purchase orders of the State Committee for Material and Technical Supply. I am not revealing anything new here. Wholesale trade in products and equipment instead of the traditional system of material and technical supply is an old problem, which has been repeatedly discussed at the most different levels. Now it is already generally recognized that it is necessary to change over to it, in particular, to develop in every possible way direct contacts between enterprises. The matter is now being held up by the search for specific forms of such a gradual transition.

There is another condition. The enterprise has the rights to establish independently, for example, within the framework of supply contracts, the prices for the product being purchased (supplied), which would differ from the prices of the prevailing price lists. In other words, it is a question of

some decentralization in pricing and the permissibility of a multiplicity of prices.

And, finally, the consuming enterprise is granted the right to formulate the plans of capital construction of its basic suppliers. For this, of course, the state should provide it with the corresponding resources. Then, for example, a motor vehicle works, and not a tire plant, will dispose of the capital investments for the modernization of the production of tires.

It is especially important for those enterprises of ours, which deal with the delivery of complete sets of products, to acquire such a powerful management "lever." For the present we have few such enterprises, their number, of course, will increase, and it would be judicious to give them immediately the right to dispose of the capital investments of supply enterprises.

Of course, in addition to the listed ones, there are also many other conditions, but they are less fundamental. But what was listed above--above-plan production, contract prices, and wholesale trade--forms a favorable economic climate and generates a flexible economic environment, which will become a tool of the protection of the interests of the consumer, will make it possible to turn the producer toward the consumer, and will afford him the possibility to directly choose the necessary industrial product.

[Question] Let us imagine that by means of the introduction of the system of statuses the equalization between enterprises has been eliminated. What will this give them?

[Answer] First of all I will note that it is possible to regard such a breakdown by statuses as a further development of our socialist principle of distribution according to labor. Here it is applied not only to individual workers, but to entire collectives.

But the differentiation according to statuses gives the most important thing--the clear vision by enterprises of their future. It is natural that they themselves will have to choose toward what status to orient themselves. A high status is also greater responsibility, a higher level of production and the organization of labor, and the strict dependence of the material benefits being received on the results of the labor of all the members of the collective. A high status aims at a turbulent life, a constant search, and, we will not conceal it, risk. Including the risk of suffering losses from incorrect decisions.

It is clear that the broadening of independence and the obtaining of broader and, at times, exclusive rights presume that not only the managers of enterprises, but also all the members of the labor collective should be ready for work in the new way.

It seems to me that the introduction of different statuses for our economic organizations will become a stimulus which prompts the acceleration of scientific and technical progress. Initiative and enterprise will then be encouraged in a natural economic manner, and will not be suppressed, as is still occurring today.

Finally, it is fundamentally important that this means of the development and stimulation of initiative, boldness, and enterprise is being monitored by the state--after all, the status of a specific enterprise will be formed only in conformity with statewide tasks.

I am confident that the conferment on one organization or another of the corresponding status will contribute to the pursuit of the scientific, technical, and socioeconomic policy, which was specified by the decisions of the 27th congress of our party.

Chermetmekhanizatsiya Scientific Production Association

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 June 86 p 5

[Interview with Viktor Grigoryevich Urchukin, general director of the Chermetmekhanizatsiya Scientific Production Association, by A. Yezhova: "Acceleration. How Did They Achieve It? An Account of V. Urchukin, General Director of the Chermetmekhanizatsiya Scientific Production Association"; date, place, and occasion not given]

[Text] [Answer] Unified temporary creative collectives are working at the scientific production association for a second year. Scientific associates, designers, and specialists of various laboratories are included in them. As a rule, for the solution of some problem we enlist four or five most skilled specialists who suggest their versions of the solution. After the choice of the optimum version the author is charged to head the temporary creative collective. He is given the right to select staff members at his own discretion. The specialists, who work in such a collective, remain on the manning table in the former positions.

In the system of the scientific production association its own method of stimulating temporary creative collectives is in effect. For this we use the fund of incentive allowances. It is placed at the disposal of the council of the collective, which distributes it in accordance with the labor and creative contribution. Half of the fund is distributed monthly, while upon completion of the work the incentive bonus is paid in full. Even if the work has been completed in advance, the bonus is paid for the entire established period.

[Question] Viktor Grigoryevich, tell me in detail what specifically has been done by these collectives?

[Answer] In all 10 developments have been completed. Now four collectives are already working simultaneously.

The temporary creative collective at the scientific production association in a short time developed a machine for the vertical casting by the centrifugal method of double-pour rolls of sheet mills. So far the centrifugal casting machine has been produced by the Novokramatorskiy mashinostroitelnyy zavod Production Association for the Lutugino Plant of Rollers. The durability of the rolls increases by not less than two- to threefold, the quality of the sheet being rolled also improves.

Less than 5 months were spent by the temporary creative collective on the development of an automatic station of oil aerosols for the lubrication of the bearings of metallurgical equipment. But each such station makes it possible to save in a year 7-10 tons of very scarce lubricating oils and increases the life of rolling bearings by 1.5-fold.

Another temporary collective accomplished the task of modernizing the line for the production of railroad mounting hardware, which was purchased in the FRG. We were able to increase the productivity of the line by 25 percent, to decrease the amount of installed equipment, and to begin the changeover to the flashless stamping of blanks. As a result the Kiserling firm was forced to purchase a license...for its own equipment.

[Question] Now much attention in the country is being devoted to the saving of resources. Is this aspect being taken into account in the developments of the creative collectives?

[Answer] When developing new equipment we show concern for the decrease of the power-output ratio of machines and technological processes and the use of secondary energy resources. A power technology unit for the recovery of the heat of molten slags and the obtaining after granulation of Portland blast furnace cement was developed jointly with the Dnepropetrovsk Metallurgical Institute and the Ukrenergochermet Trust.

The new method of the dry granulation of slags, which was used in it, eliminates the expenditures on fuel during drying at cement plants. They range from 80 kopecks to 1 ruble per ton of granulated slag. The saving from the recovery of heat is 64 kilograms of standard fuel per ton of molten slags. Actually this is steam with a temperature of 140-160 degrees and a pressure of 12-14 atmospheres, which is used here at the metallurgical combine for heating.

It is envisaged to start up the experimental unit this year at the Zaporozhstal Combine. Now all the equipment has been produced, the construction work has begun.

[Question] What, in your opinion, is the advantage of unified temporary creative collectives as compared with the usual form of the organization of work?

[Answer] Whereas the process of developing equipment usually takes place in sequence, the organization of temporary creative collectives makes it possible to carry out simultaneously the development of the components of a complex of machines. This makes it possible to shorten the time of development to one-half. Owing to the combination of the process of work on various assemblies, it is possible to obtain more compact equipment, with a smaller specific power-output ratio and metal content.

In other words, it is possible to solve the problem in a shorter time and comprehensively.
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MEASURING OF ELECIRICITY, HEAT, GAS, WATER CONSUMPTION

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 2, 8-21 Apr 86 pp 4-5

[Article on round table of NEDELYA and NTR: PROBLEMY I RESHENIYA, conducted by O. Iebedeva, under the rubric "Resources of the Country. The Search for Reserves": "Saving Begins With Counting. How Is the Reliable and Mass Instrument Monitoring of the Consumption of Electricity, Heat, Gas, and Water to Be Ensured?"; first 10 paragraphs are NTR: PROBLEMY I RESHENIYA introduction; last 6 paragraphs are NTR: PROBLEMY I RESHENIYA conclusion]

[Text] This burning issue, which for so long remained in the country "in the background" of scientific and technical progress, has already grown to the scale of a national economic problem, which it is necessary to work on and solve as quickly as possible. Statistical data, which have been taken almost at random, also confirmed this. For example, less than 10 percent of the need of municipal services alone of the RSFSR for heat meters for central boiler houses and hot and cold water meters is being met.

Hence, nine-tenths of the heat and water on the territory of our largest republic, where 80 billion kilowatt-hours of electric power and 10 billion cubic meters of water are consumed in a year, are being used without instruments, which in essence means without control. Any unjustified loss of natural raw materials is immoral. Living labor, which is becoming more and more expensive with the years of our growth, is invested in them. "...We have begun to pay a dear price for the extraction and delivery of each ton of petroleum, ore, and coal," it was emphasized at the 27th CPSU Congress. "One must not close his eyes to these facts, it is necessary to consider them. And to economize on everything and everywhere--at the works and in daily life, not to pass over with indifference poor management and waste." "To economize in everything and everywhere" first of all means to set up metering "in everything and everywhere." But metering is possible only given objective instrument monitoring of the resources being consumed. The creative interests of two editorial collectives: of NEDELYA and NTR, also met in the analysis of the state of this problem and the search for means of its solution. We have different readers and tasks. And the fact that the goal proved to be common once again confirms not simply the urgency of the problem, but, let us venture to say, the universal anxiety about and intolerance of the very fact of its existence.

The problem is discussed by:

--Yu.M. Dubrovin, deputy chief of the Instrument Making Department of the USSR State Planning Committee;

--E.I. Akopov, chief specialist of the Instrument Making and Radio Electronics Department of the State Committee for Science and Technology;

--V.I. Vinnik, deputy chief of the State Inspection and Territorial Organs Administration of the State Committee for Standards;

--Yu.M. Sosner, chief project engineer of the Central Scientific Research, Planning, and Experimental Institute of Engineering Equipment of Cities, Apartment Houses, and Public Buildings of the USSR State Committee for Civil Construction and Architecture;

--L.M. Gorbachev, chief of the Department of Norm Setting and the Efficient Use of Material Resources of the Instruments Main Administration of the USSR State Committee for Material and Technical Supply;

--A.N. Voldorin, deputy chief of the Main Production Administration of the Ministry of Instrument Making, Automation Equipment, and Control Systems;

--Yu.S. Malkhazov, chief of a department of the Science and Technology Main Administration of the Ministry of Instrument Making, Automation Equipment, and Control Systems;

Instruments and Economy

[Question] Does saving need instruments?

Having asked to start with this seemingly indisputable question, we heard the following.

Yu.M. Sosner: Flowmeters, of course, are needed. Resources, like money, require counting.

A.N. Voldorin: If steam is coming from a broken pipe, it is necessary not to measure the losses, but to fix the pipe. As to the payment for the resources being consumed, the losses should be paid for at higher rates than ordinary consumption.

Yu.S. Malkhazov: There are electric meters everywhere in apartments. But do they force people to be economical? I, for example, do not even look at mine: I simply know approximately how much electricity I use, keep a record, and pay for it.

Yu.M. Sosner: And nevertheless, when leaving, for example, the bathroom, you probably turn off the light there.

[Question] But is it possible to turn off the radiator in a room?

Yu.M. Sosner: This is also becoming possible. The Bologoye Plant has begun the production of ball cocks for the individual regulation of apartment heat. Some 150,000 have already been made. In quality, note, they are not inferior to the best analogs. The developer is the VNIIavtogenmash.

During this five-year plan 9 million of them will be produced. The installation of such cocks everywhere is envisaged by the Construction Norms and Regulations (SNiP). So that now it will also be possible to regulate the consumption of heat. But there is nothing to measure with.

Incidentally, a gauge is needed not only to know how much to pay, but also "to know by sight" those who waste energy and fuel, heat and water. Indeed, let us say, the owner of a heat meter will pay only for the heat which has gotten to the consumer. The producer of the heat or the one responsible for the networks will have to pay for what has gone "to the wind" on the way, due to poorly insulated pipelines.

Thus, the meter is capable of imposing economy and prompting technical improvement. Of course, not the meter in itself, but, I will emphasize, the meter first of all.

V.I. Vinnik: It seems to me that in this matter there cannot be two opinions. V.I. Lenin taught that socialism is metering, in our times the metering of all resources without modern means and methods of measurement is simply impossible. This should be constantly remembered when working on problems of this sort. Thus, it is necessary to measure the consumption of resources, and as accurately as possible. Gigantic labor of millions of people is invested in them. And, in addition, it is a question here of resources, the expenditures of which nature is no longer capable of compensating for. Figuratively speaking, the bottom of the natural reservoir has become visible--the time of saving has arrived. It begins with counting, but it does not and cannot exist without a measuring instrument.

E.I. Akopov: Here it is necessary to take into account that the measurement of heat flow rates alone is insufficient for genuine saving. This is a complex problem. Instruments for the checking of both the quality of water preparation at thermal electric power plants and nuclear electric power plants and the composition of the fuel and the completeness of its combustion are needed. Incomplete combustion is not only the venting of fuel into the smokestacks, but also additional air pollution....

L.M. Gorbachev: Let us say that you intended to spend your vacation in the south, having used your own car. You will certainly adjust thoroughly the speedometer and gas gauge! At least in order "not to bask in the sun" along the road, in some by no means sunny remote place with an empty gas tank.

Here, perhaps, is the entire "ideology of flowmetering" for you. Both saving and the economy, the advantage of both the producer and user are there. The instrument signal is the initial impetus of assiduity.

[Question] And the more accurate the readings of the instrument are....

V.I. Vinnik: The expenditures on accuracy quickly pay for themselves. As to the metering of resources (electric power, heat, gas, petroleum, coal, water), in recent years the accuracy of their measurements has increased in the world by more than tenfold. But we, let us face it, still lag in this matter.

E.I. Akopov: Recently the International Measuring Equipment Organization (IMEKO) calculated that in the cost of modern production the expenditures on measurements come to 50-60 percent. And they are considered profitable.

V.I. Vinnik: In our country the permissible error of the calculation of the consumption of electric power with respect to large electric power plants and substations was fixed by the Ministry of Power and Electrification at 0.5 percent. World experience confirms: this is entirely achievable. However, our specialists are detecting significantly greater errors in the metering of electric power--up to 4 percent.

Unaccounted for Heat....

[Question] But what is the situation with heat gauges?

V.I. Vinnik: With heat it is even worse. In our country in practice they simply do not measure it. At best they present a large consumer with bills which are based on rated capacities. But this indicator, as is known, is extremely relative.

[Question] What is the solution?

V.I. Vinnik: It is necessary that the consumer would pay only for the heat which he actually received. Only then will the producer begin to increase the coefficient of heat recovery from the heat carrier and decrease its specific consumption. Be economical!

But for the present there are neither heat measurements nor heat flow meters, even unreceived heat is actually paid for, all consumption of the heat carrier is covered. In accounting a balance is obtained, while in the economy, as well as in ecology everything is the opposite.

[Question] And is it taking place unnoticed?

V.I. Vinnik: Now this depends, I beg your pardon, only on the observer.

Have you really not seen, particularly in Moscow, in winter clouds of steam above the city roadway, snow-free lawns, even lawns which are turning green? Last year in Belgorod, for example, it went so far that hot water and steam put roads out of service.

[Question] This is an extreme situation, but do the corresponding signal instruments exist?

E.I. Akopov: Infrared imaging equipment exists. Even quite reliable domestic infrared imagers exist. They can show how much a heat line heats up the asphalt, moreover, not only in winter, when this is evident from melted snow,

but also in summer. It is also possible to "see" how the heat, which is being fed within houses, escapes through the walls into the street.

But so far a heat map has not been completely compiled even for the capital. But, meanwhile, it is possible to do this not only by means of space equipment, but even with a simple airplane. Or directly from a motor vehicle, as the Swedish firm AGEMA is doing in practice.

L.M. Gorbachev: The total need just for industrial meters and regulators of heat (steam and hot water) has already reached 1.4 million units. But of the 12,000 large users of heat in Moscow only 1,800 have such instruments.

V.I. Vinnik: Back in 1982 heat meters like the FS-31M, FS-34, and FS-35 successfully underwent state tests, but the Ministry of Instrument Making, Automation Equipment, and Control Systems so far has not assimilated their production. In our opinion, it is also advisable to speed up the organization of the production of heat meters like the TEM-1, which were developed by the Nefteprибor Special Design Bureau (Baku).

It is also advisable to set up the production of heat meters in the necessary quantities at the Lenvodopribor Plant of the Leningrad City Soviet Executive Committee on the basis of induction flowmeters, which have given a good account of themselves. Here one should constantly remember the quality of the instruments.

In 1985 we were forced to forbid the Tallinn Prompribor Production Association of the Ministry of Instrument Making, Automation Equipment, and Control Systems to produce TS-20 heat meters in connection with their low quality.

The problem of checking heat meters also remains unsolved. The Ministry of Instrument Making, Automation Equipment, and Control Systems so far has not developed and has not organized the production of test units.

L.M. Gorbachev: Even new instruments, which are still just being developed, frequently do not satisfy the demands of the present technical level on accuracy and reliability, because they are based on obsolete initial demands.

For example, even if there are enough TEM-1 heat flow meters, their use in the existing systems of measurements, in which the volume of water, which has passed through the pipe, times the difference of the temperatures at the beginning and end of the heat line is taken as the quantity of heat, will not make it possible to identify the specific wasters of heat. For the meter takes into consideration the average temperature for a quite large rayon of the city, in which one apartment house is located closer along the pipe to the heat and electric power plant and receives hotter water, another is located farther away, and so on. I believe that the Ministry of Power and Electrification should undertake the formulation of initial demands, which correspond to the world level, in the technical assignments for metering instruments which are being newly developed and modernized.

Yu.M. Sosner: This work is already being performed. A goal program, in conformity with which the production of heat flow meters, which satisfy such

demands, will be assimilated by the end of the five-year plan, has been approved.

E.I. Akopov: In Chelyabinsk they have already begun as an experiment to use thermostats in apartments. These are new electrochemical zirconium sensors. They send a standardized signal to a computer, which controls heat consumption from the source of heat supply.

Nevertheless, for the present standard designs for housing and production buildings with the use of instruments for the automatic local monitoring and regulation of heat consumption have not been drawn up in our country. At the same time the lack of the necessary number of instruments is hindering their use in standard designing.

Yu.M. Sosner: The State Committee for Civil Construction and Architecture is completing the development of standard heating units for houses, which contain automatic control instruments. In addition to this advantage, by having such an instrument, the DEZ will no longer have to pay extra money to the same Moscow Regional Administration of Power System Management.

[Question] What is the result? It is necessary to build new plants and to reconstruct apartment houses. And, they say, it is also necessary to reconstruct the underground water mains, uniting all the service pipes into an apartment into a single one.... Has anyone compared if only at the qualitative level the present losses of resources with the cost of the program of ensuring their metering? Is the game in the end worth the candle?

L.M. Gorbachev: If we are speaking about the introduction of systems of automated heat supply and heat consumption, this will cost 250 million rubles. By the end of the commenced five-year plan this will make it possible to save annually 4.7 million tons of standard fuel. Multiply this figure by 17-20 rubles--such is the cost of 1 ton of standard fuel--and you will see that the expenditures will pay for themselves in approximately 3 years. So that the game is worth the candle!

Both Gas and Electricity

[Question] About 20 years ago gas meters, I remember, were in every apartment. What has become of them?

Yu.M. Dubrovin: They abandoned them, since they were unsafe. And they began to collect payment according to "the norms of the average per capita consumption."

V.I. Vinnik: And now about half of all the gas is being consumed in the country in general without any standard, according to so-called unit norms.

Frequently the amount of consumed gas (especially at small boiler houses) is determined according to the diameter of the gas main and the pressure of the gas or the rating of the burners. Gas is "metered" in this way at 39 boiler houses of the Dneproteploset. The determination of the qualitative indicators of the gas and its calorie content has been poorly organized at them. But

metering is not only the quantity, but also the quality. For example, the actual calorie content of the gas, which is supplied by the Black Sea Petroleum and Gas Production Association to the Krymgaz Production Association, was systematically overstated, but the price of gas directly depends on its calorie content....

A significant number of unsuitable means of measurements are being used at enterprises of the Ministry of the Gas Industry and the Ministry of Housing and Municipal Services of the union republics. For example, at the Gorkiygorgaz Trust 78 percent of the measuring instruments were rejected. This is also the main cause of the unsatisfactory metering of gas. There is also nothing with which to check the turbine meters for the metering of gas, which are used in municipal services. The Ministry of Instrument Making, Automation Equipment, and Control Systems is again to blame for this.

Yu.M. Dubrovin: The organization of the production of gas meters at one of the enterprises of the Ministry of Instrument Making, Automation Equipment, and Control Systems is already being planned.

Moreover, a decision on the purchase of gas meters in the CSSR has been made. The first batches of them will soon arrive in the country.

[Question] When will the need for gas meters be met?

Yu.M. Dubrovin: If all the coperformers of the planned measures, and first of all the Ministry of Instrument Making, Automation Equipment, and Control Systems, fulfill their obligations, the needs, at least for the RSFSR--500,000 gas meters a year--will be met already during the current five-year plan.

[Question] But are there enough electric meters in the country?

Yu.M. Dubrovin: The situation with them differs from the one that has formed with other flowmeters: we have been provided with apartment electric meters at the level of 80-90 percent. The most energy-intensive consumers--first of all industrial consumers with the most impressive losses of this resource--are being monitored most poorly of all. The need for industrial electric meters is being met at the level of 60 percent.

If the production of three-phase meters is doubled, in 1990 the largest flow of electric power will finally be taken under control.

Yu.M. Sosner: And all the same this cannot reassure us. The point is that among the resources, about which we are speaking, electric power, without particular stretching of the point, can be called the initial or, if you wish, primary resource.

Today it is impossible without it to obtain either fuel or water, even cold water. Before it flows into your washstand or fills the teakettle, it is necessary to extract it from the depths, prepare it, purify it, and lift it to the floor on which you live. Electric power also works for all this, just as,

strictly speaking, for the preparation for use of gas, gasoline, heat, and so on.

So that the instrument metering of the consumption of all natural resources should begin with electric meters. But it cannot, of course, be limited to them. For the arsenal of flowmeters should work in concert for the most leakproof "control blockade," which cuts off all channels of losses.

Of course, the efficiency of the saving of resources is coming up against a large number of problems. But only the metering instrument is capable of catching on in order to pull out the entire "string" of these problems.

A.N. Voldorin: But is it not better to begin with the "string"....

V.I. Vinnik: No, the effective saving of resources begins only with an instrument. Via the "string" we will get, as they say "to the mine," but there is no one there to make responsible. That is, we will bury responsibility.

Order Is the Head of Everything

[Question] Thus, our last question. With what does saving begin?

L.M. Gorbachev: I believe with responsibility for the saving of resources, and this means responsibility for the introduction of an effective system of the stimulation of the producers, distributors, and users of a resource. First of all the most scarce, energy-consuming, and labor-consuming ones.

Yu.M. Sosner: While I, on the contrary, think it starts with defendants.

V.I. Vinnik: It seems to me that every truth is concrete. Therefore, here is what I want to direct your attention to.

We have the means of measurement, which are necessary for reliable metering and the identification of any losses of heat and, hence, both heat carriers and electric power. I have already spoken about the fact that an excellent design of hot water meters, which is not inferior in technical level to foreign analogs, has been developed. But for 6 years now the instrument making sector has been holding up their assimilation. And first of all due to the poor organization of the matter.

Everything is coming up against the need for the establishment of order with the assimilation of the mass production of a range of meters, which encompass with monitoring the entire chain of the obtaining, transportation, and use of resources. Production which, as I am convinced, it is also possible to organize under existing conditions.

This concerns first of all the instruments, designs of which have been developed and experience in the production of which exists. The hold up is merely with the realization of the need to do this, without citing various difficulties....

Yu.S. Malkhazov: Here much is being said about the Ministry of Instrument Making, Automation Equipment, and Control Systems. But imagine for a minute that our sector has already supplied everyone with all the needed meters.

So I ask: Will they be able to install, operate, and regularly check them? For it is necessary not only to make instruments, having spent vast assets and again resources. Incidentally, the Ministry of Instrument Making, Automation Equipment, and Control Systems is already producing 70 million rubles of this equipment annually, while by 1990 will provide 100 million rubles more a year. The range of instruments has been specified and measures on the expansion of production have been elaborated for this prospect. I will not waste time on further enumeration. I will merely say that this problem is a general one.

For example, not one present DEZ is capable of installing computerized heat meters, since it does not have any other facility, except a damp basement, which is unsuitable for this, and also does not have competent personnel.

That is why we believe that the lack of instruments today is not the main problem.

Yu.M. Sosner: Apparently, only because for 15 years now your sector has not been able to do anything with this lack, in spite of a large number of government directives on the production of flowmeters and other metering instruments.

Yu.S. Malkhazov: With respect to this question the Ministry of Instrument Making, Automation Equipment, and Control Systems can present the corresponding materials and reports.

V.I. Vinnik: You will not replace deeds with a document. Measuring instruments are needed, and not reports. Without modern instruments we will not solve the problem of the efficient production and use of the fuel and energy resources of the country.

E.I. Akopov: It is necessary to realize at last the need for a comprehensive approach....

Yu.M. Dubrovin: We have already learned to approach problems comprehensively. But one must not only approach problems, it is necessary to solve them. But coordinated actions of all the coperformers and the ability of each one to take upon his shoulders the burden of accomplishing the tasks, which no one except him will fulfill, are needed for this.

E.I. Akopov: I also have precisely this in mind.

Yu.M. Dubrovin: There are many most diverse programs. Signatures of responsible officials are on all of them. But too often the matter also ends with such a signature. One must not simply sign, it is necessary to weigh one's possibilities. And to sign only when they exist, and not to create the illusion of well-being. This is both a moral and an economic question.

How do they now escape responsibility? They nod in the direction of the supplier. Everyone should do his own job and advance the matter in his section. And by contributing thus to the success of the common cause, to reveal in passing the exposed sections and, hence, the specific perpetrators of the underfulfillment of one comprehensive program or another.

L.M. Gorbachev: Quite correct. But the plant also should in no case work for the warehouse. Now, for example, in the Ministry of Instrument Making, Automation Equipment, and Control Systems heat regulators, which it is necessary to make into a complete set with elevators of the Ministry of Chemical and Petroleum Machine Building, have been lying in the warehouse for 2 years now. Why? It would be better for us to place the scarce materials, which were used in the "extra" regulators, into the production of instruments for nuclear electric power plants. The Ministry of Instrument Making, Automation Equipment, and Control Systems should make exactly as many instruments as the Ministry of Chemical and Petroleum Machine Building has provided components for them.

I believe that pressure on related industries through surpluses is an expensive and harmful means. It is most efficient to coordinate the production of instruments and accessories in the long-range plans.

E.I. Akopov: Before the end of the conversation it is worth speaking about another important lever of saving--material stimulation. But for the present there is no all-union statute on the payment of bonuses for the saving of heat. A new law on calculations for thermal energy, which takes into account the coming mass supply with measuring instruments, is needed. Is it perhaps even worth announcing through the press a competition for a better suggestion on the saving of heat?

A.N. Voldorin: In order to establish order, it is necessary to adjust economically the self-organizing system, in case of which the metering of energy, its supply with instruments and methods, and so forth are advantageous to everyone.

Yu.M. Dubrovin: Today a draft of the five-year plan (for 1986-1990) and individual documents, in which measures on the creation of production capacities and the development and assimilation of the production of new means of metering resources are envisaged, have been drawn up. In these basic documents it is envisaged to increase by more than twofold the output of such equipment and to increase its quality and reliability.

The task, first of all for the Ministry of Instrument Making, Automation Equipment, and Control Systems and its institutes and enterprises, of fulfilling the outlined assignment on the automation of the consumption and metering of resources in the country is now arising.

All the participants in the held discussion came out in favor of the utmost saving of the resources which were discussed. But all the same in a different, perhaps, key.

The instrument makers, unfortunately, have not revealed the willingness to take upon their shoulders a portion of the concerns, the lion's share of which is beyond the strength of anyone else.

The gravitation toward paper complacency also did not evade the round table. The complacency which breeds an uncountable number of discussions and consultations, plans and programs, with the signing of which many have become accustomed to consider the job done, although it really only begins with this.

Perhaps, the most valuable thing is that during the exchange of opinions the points of view of the State Committee for Standards (V.I. Vinnik), which rigorously insists on the need for a responsible attitude toward the provision of the national economy with the entire range of modern flowmeters, and the Ministry of Instrument Making, Automation Equipment, and Control Systems, the representative of which (A.N. Voldorin) insisted that the saving of resources and, hence, its supply with instruments--all this should become advantageous, while deviation from this should irreversibly be punished economically--in the end agreed.

Indeed, then the ideas, which were set down in the coordinated documents, will begin to be realized. And, specifically speaking, the achievement of the goals set in the Basic Directions will be reliably supported practically and technically:

"To tighten up consistently the policy of economy, which is one of the most important factors of the intensification of production. To turn resource saving into a decisive source of the meeting of the needs of the national economy. To see to it that 75-80 percent of the increase of the needs for fuel, energy, raw materials, and materials would be met by means of their saving. To decrease the power-output ratio of the national income by a factor of not less than 1.4."

PHOTO CAPTIONS

1. pp 4-5. A.I. Darmanov, senior scientific associate of the Scientific Research Institute of Heat Engineering Instrument Making, adjusts a vortex flowmeter which is intended for systems of the monitoring and regulation of the consumption of liquid. The instrument has a high accuracy and reliability in a wide range of measurements and with respect to its basic technical characteristics is not inferior to foreign analogs.

2. p 5, left. The TEM-1 heat meter of the electron-mechanical type at the Sanitary Engineering Construction Pavilion of the Exhibition of USSR National Economic Achievements. The instrument was developed by the Neftekhimpribor Special Design Bureau (Baku) and is intended for the measurement of the total amount of thermal energy which is being fed to buildings and other structures. As compared with the preceding models the TEM-1 is distinguished by a greater accuracy of measurements, a decreased consumption of

electric power for its own needs, and a lower materials-output ratio and cost.

The instrument was developed in accordance with an assignment of the Central Scientific Research, Planning, and Experimental Institute of Engineering Equipment of Cities, Apartment Houses, and Public Buildings.

3. p 5, right. The VSKM water meter--a highly sensitive small instrument, which is capable of measuring even the smallest consumptions of cold water. This development of the Scientific Research Institute of Heat Engineering Instrument Making can be used both at the works and in case of household water consumption.

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FROLOV ON TASKS OF MACHINE SCIENCE INSTITUTE, AFFILIATES

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8, 22 Apr-5 May 86 pp 4-5

[Interview with Vice President of the USSR Academy of Sciences Academician Konstantin Vasilyevich Frolov by A. Lepikhov: "Machine Building: The Strategy of Development"; date, place, and occasion not given; first paragraph is NTR: PROBLEMY I RESHENIYA introduction]

[Text] Machine building is the basis of scientific and technical progress in all of the sectors of the national economy. Here in the next few years we have to achieve a sharp increase of the technical level of the output being produced, to ensure the development and assimilation of the production of equipment of new generations, which makes it possible to increase labor productivity by many fold and to decrease material expenditures substantially; the material, scientific, and technical base of machine building should be strengthened substantially. It is impossible to accomplish these tasks without the closest interaction of academic research institutions with sectorial scientific research institutes, design bureaus, scientific production associations, and large enterprises, without, on the one hand, the conducting of basic research, which is oriented toward the future, and, on the other, the development of the mechanism of the "response" of academic science to the urgent problems of the machine building complex. At the request of our correspondent Vice President of the USSR Academy of Sciences Academician K.V. Frolov tells about the problems of Soviet machine building and the role of the Academy of Sciences in their solution.

The Research Echelon of Machine Building

[Question] Konstantin Vasilyevich! The machine building complex of our country is indeed enormous. Therefore, let us limit the theme of our discussion just to the problems of machine building, which are being worked on at the USSR Academy of Sciences. And, if you agree, I would like to ask the first question: What tasks of the development of machine building face basic science today?

[Answer] Today the USSR Academy of Sciences, jointly with the academies of sciences of the union republics and the sectors of industry, is working on the fulfillment of the program of basic research for 1986-1990. Its basic directions are the automation of machine building, the increase of the

reliability and life of the machines and equipment being produced, the development of new construction materials, the making of a technical and economic analysis of the problems of the machine building complex, and the development of cooperation with the CEMA member countries. The work on the information support of the priority direction "Complete Automation" of the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries has been started at the Institute of Machine Science of the USSR Academy of Sciences jointly with the International Scientific and Technical Information Center. The goal of this work is to encompass by means of databases and data banks the world flow of documentary and factual information in the field of the basic and applied problems of machine building. (Footnote 1) (See NTR: PROBLEMY I RESHENIYA, No 4, 1986)

It is natural that academic scientific institutions are concentrating their efforts mainly on the development of the theoretical principles of fundamentally new types of high-performance equipment and promising technologies, on the extensive use of computer-aided design systems and computer hardware for the designing of machines and components, the control of technological processes, and the complete automation of machine building. The new Problems of Machine Building, Mechanics, and Control Processes Department was established at the USSR Academy of Sciences for the purpose of the development of the scientific potential and the experimental, experimental design, and production base, as well as the concentration of the available resources for the comprehensive solution of the urgent problems of machine building. Prominent academic institutes have been included in it.

Unusual Associations

A number of interbranch scientific technical complexes (MNTK's), including the Reliability of Machines and Robot Complexes, were established on the initiative of the USSR Academy of Sciences and the State Committee for Science and Technology.

Within the Reliability of Machines Interbranch Scientific Technical Complex, which I have been commissioned to head, work has been started on increasing the reliability of all machine building products. The fundamental approach to the solution of this most important problem is clear--the reliability of new equipment should be incorporated already at the stage of the elaboration of the technical specifications and the technology of the production of an innovation.

The task of the Robot Interbranch Scientific Technical Complex is to develop highly efficient machines, devices, and technological processes on qualitatively new principles and the development, large-scale introduction, and assurance of the highly efficient operation of robotic transport systems. Another direction of its work is the improvement of the methods of diagnosis of robotic systems in machine tool building and their introduction in the practice of our production associations.

In recent times the Institute of Machine Science imeni A.A. Blagonravov--the main academic organization in the area of problems of machine building--has been strengthened appreciably. Affiliates of the Institute of Machine Science

have been organized in Gorkiy, Sverdlovsk, Leningrad, and Saratov; the necessary preliminary work on the establishment of similar affiliates in Kuybyshev and Volgograd is being performed.

Outlying Centers

[Question] Two questions simultaneously: From what did the choice of precisely these cities stem and why did you not take the customary route--the establishment of independent scientific research institutes, but made the new research collectives affiliates of the Institute of Machine Science of the USSR Academy of Sciences?

[Answer] I will answer the second question first. I have already had occasion to speak about this at the 27th CPSU Congress and still will repeat it once again. At one time at the academy the role of the technical sciences was obviously underestimated. The Technical Sciences Department, which previously existed, was dissolved, while a number of institutes of the technical type were withdrawn from the Academy of Sciences. During the past years several of them have been repeatedly transferred from one department to another, have lost fundamentality, have ceased to engage in promising research, and have lost creative personnel.

By establishing not independent scientific research institutes, but precisely affiliates of the Institute of Machine Science, which has a large number of scientific schools, fine traditions, and a developed experimental base, we hope that all this will be perceived by the new research collectives and will enable them to attain quickly a modern level of research and to obtain the first results.

Now the answer to your first question. Let us take, for example, the city of Gorkiy. It is one of the largest industrial and scientific centers of the country.

In Gorkiy Oblast they are making motor vehicles and ships, are producing airplanes and machine tools, and are developing modern measuring instruments and advanced power equipment. The products of the Volga-Vyatka Industrial Region are being delivered to 80 countries. And at the same time there is not one specialized scientific research institute here, which would engage in the solution of the intersectorial problems which arise when developing modern equipment and new technology. The results of such "isolation" of the practice of machine building from basic research and development are well known--many industrial items have too high a metal content and a low competitive ability on the world market, in them there are still not enough fundamentally new technical solutions.

It is quite natural that in Gorkiy, after the organization of the affiliate of the Institute of Machine Science, basic research, the goal of which is the increase of the quality and reliability of machines on the basis of the use of such latest technologies as plasma, laser, and powder technology, will be developed. Here they will also begin to develop methods of analysis of the fatigue strength and wear resistance of strengthened elements of components, to develop computer-aided design systems, and to improve the methods of

decreasing the materials-output ratio of machine building products by means of the optimum use of namely those advanced technologies about which I have spoken.

Such a wide range of research requires that specialists in mechanics and applied mathematics, physics and the theory of the planning of the experiment and experts of computer technology and optimization problems would work at this affiliate. The increase of the number of workers will occur mainly owing to young graduates of higher educational institutions, including, of course, Gorkiy University imeni N.I. Lobachevskiy and Gorkiy Polytechnical Institute imeni A.A. Zhdanov.

The Sverdlovsk and Saratov affiliates of the Institute of Machine Science will be the largest of the affiliates being established.

In Sverdlovsk the Department of Complex Problems of Machine Building, which was previously established within the Institute of Metallurgy of the Ural Scientific Center of the USSR Academy of Sciences, became its basis. Today a substantial reserve in the development of a casting and rolling complex for the production of hot-rolled thin steel strip directly from molten metal already exists, research is being conducted on the development of a continuous process of the acid-free removal of scale from steel. What will the fulfillment of just this portion of the work yield? To obtain from each ton of molten metal 850-950 kilograms of finished rolled products (instead of the present 650-750 kilograms); in the production of 100,000 tons of blanks of parts to save approximately 70,000 tons of metal and to free about 8,000 workers; to solve effectively the problems of environmental protection in the zone of metallurgical and machine building plants.

I will add that the results of the Ural scientists have substantial novelty and are aimed at the development of systems of machines, which in their technical and economic parameters will surpass the best systems for similar purposes both in our country and abroad.

In Saratov, where scientific schools in machine building, which are famous in the country, have been established, electronic engineering and instrument making have undergone much development. The solution of the problems of automation in machine building is becoming the basic direction of the activity of the affiliate of the Institute of Machine Science. The base of this automation is new technologies, computers, robotic systems and microprocessor equipment, computer-aided design systems at design bureaus and industrial enterprises. The introduction of the developments of scientists will be significantly facilitated owing to the fact that experimental design bureaus and a pilot plant are also a part of the affiliate. Here, just as at our other affiliates, it is by no means necessary to start the work from zero. Many interesting developments already exist at Saratov sectorial scientific research institutes and design bureaus. I have in mind, for example, a robotized lathe module, which is controlled by a microprocessor. Measuring equipment, which was developed on the basis of a laser, noise-free drives, and so-called aerostatic supports are being used here. The Saratov scientists and engineers developed a transporter with artificial intelligence, developed a number of robotized complexes, which are easily readjusted, for assembly

processes, and developed and introduced original computer-aided design systems and plant technical management automation systems (ASUTP). An entire school of the physics of failures of components of automatic equipment is also being successfully developed here.

And, finally, about the last of the already established affiliates of the Institute of Machine Science--the Leningrad affiliate.

The establishment of the Leningrad affiliate is making it possible to turn basic science toward the solution of engineering problems in machine building, to increase the volume of the general scientific "reserve" for the future, to generalize advanced know-how in good time, and to forecast the trends of development of the leading sectors of machine building. The staff members of the Leningrad affiliate will also carry out the evaluation of the technical level, determine the need for items of new equipment, work on the development of optimum methods of the management of the potential of machine building, as well as seek effective means of the introduction in machine building of automated systems, complexes, and entire works.

Here is what circumstance is also significant. The many years of experience of the creative cooperation of the Institute of Machine Science with such production associations as the Leningradskiy metallicheskiy zavod, Kirovskiy zavod, Elektrosila, and other associations are already being used in the formulation of the thematic plan of research of the affiliate and the interaction of the young scientific institution with Leningrad industry. It is a question of the cooperative use of the already existing pilot experimental bases, the production of prototypes, the conducting of full-scale tests, the acceleration of the processes of the preparation of series production, and the increase of the skills of specialists of industry.

The principle of certain self-sufficiency is common to all our affiliates. They should earn themselves about 40 percent of the assets, which are necessary "for life," including economic contracts with the corresponding industrial enterprises.

But I would like to note that the organization of affiliates of the Institute of Machine Science is not the only method of strengthening the machine building subdivisions of the USSR Academy of Sciences. We are also not forgetting about the traditional means--the organization of new research institutes. Thus, for example, in December of last year the academy's Institute of Problems of the Superplasticity of Metals was established in Ufa. A design and technological bureau and a pilot works, which are also located in Ufa, belong to this institute.

Beyond the Known

[Question] Do you mean the study and use of the phenomenon of superplasticity, which was discovered in his day by Academician A.A. Bochvar?

[Answer] It as well. You and I have already spoken about the improvement of the surface properties of parts by means of modern strengthening technologies. But it is possible to achieve very much, if you also take a different, more

difficult, but rewarding path--the improvement of the very structure of metal. The essence of the phenomenon of the superplasticity of metals is the following. It turns out that, by selecting a specific temperature and rate of deformation of parts, it is possible to control the very process of the formation of the crystalline structure in a metal or alloy. In this case the forces, which are needed, say, for the stamping of parts, are reduced by several fold. But this is not enough. After such treatment the part has only very small residual internal stresses, or they do not exist at all. While for this reason fatigue cracks do not form and do not develop, and, hence, the life and serviceability of such a part increase by several fold. Today technological processes, which were developed on the basis of the use of the effect of the superplasticity of metals, are already beginning to be introduced in the practice of machine building.

But, of course, for the present far from all the fine points of this complex effect are yet clear to us. The collective of the new academic institute will deal with the problems of the physics and mechanics of superplastic deformation, will devise physical and mathematical models of the mechanism of the superplastic flow, will develop methods of the transition of industrial alloys to a superplastic state, and so on.

[Question] Konstantin Vasilyevich! You have spoken about the work of interbranch complexes and new academic institutes and the organization of affiliates of the Institute of Machine Science, but have not spoken about the developments of the staff members of the Institute of Machine Science itself, of which you are the director.

[Answer] The themes of our institute are broad, and, therefore, I will limit myself only to individual examples of practical developments.

The Latest Equipment

Our laboratory for the problems of the reliability of robotic systems has been organized at the Krasnyy proletariy Machine Building Plant. Owing to the joint labor of scientists and production workers it was possible in a short time to develop a production prototype of a robot of a fundamentally new type, which is based on the resonance effect. In this case power consumption was reduced here to one-seventh to one-fifth, the metal content--due to the use of composites--was reduced by approximately one-third, the reliability of the robot increased by several fold.

A laser technological complex with the programmed movement of the beam over the surface of the part being machined was also developed at our institute. Such complexes can be used successfully in flexible machine systems.

Today composite construction materials, that is, those in which a polymer or metal is reinforced with fibers of carbon, boron, silicates, or even organic compounds, if it is possible to put it this way, "are coming into vogue." By using such materials, it is possible to achieve a decrease of the weight and an increase of the strength and durability of parts. But what composite is to be chosen? For process engineers today can think up practically an infinite number of them! It turns out that it is possible to predict the properties of

the needed composites. Unique algorithms and programs of the optimum designing of the structure of composites have been developed at our institute. Their use is making it possible to decrease the weight of parts made of composites, as compared with traditional construction materials, by 20-30 percent.

Staff members of our institute and workers of the Leningradskiy metallicheskiy zavod Production Association are the authors of another interesting development. It is a question of promising methods of the repair of large-size equipment, which were able to originate only after the thorough study of fracture mechanics. For example, large hydraulic turbines, mining equipment, and construction and road machines are already being repaired, by welding a very tough metal onto the damaged spot. It is possible to "stop" a defect, without allowing it to achieve a critical state.

Technological Changes

I cannot but speak about the use in machine building of vibration and ultrasonics. This direction is also being successfully developed at the Institute of Machine Science. Without vibration engineering it is already impossible today to drill ultradeep boreholes, to dress mineral ores, to develop pipeline transportation, and to transport bulk cargo. Pumps without rubbing parts were developed on the basis of the principles of vibration conveyance. By means of them it is possible to pump not only liquids, but also so-called multiphase systems which contain solid inclusions. Vibrating conveyors, beyond a doubt, will be an important component in the transportation systems of "unmanned plants" of the future.

A special place among the diverse vibrating machines and devices belongs to ultrasonic systems. By using the intensity and spectral composition of ultrasonic radiation, it is possible to influence those internal structures of metals, which determine its strength and plasticity. The promise of this technological direction is indisputable, since the theoretically achievable ultimate strength of metals, which have been treated with ultrasonics, is nearly a hundredfold greater than under ordinary conditions. What has been said means that only a negligible portion of the enormous resources, which metals have in principle, is being used even in the best components which are being developed today. But ultrasonics helps not only to strengthen metals, but also to process hard alloys, diamonds, ceramics (remember the ceramic internal combustion engines which are emerging!), and semiconductors--in short, the materials which do not lend themselves to working by traditional methods.

In concluding our conversation, I want to say the following. Yes, now we are performing much intense work on the improvement of the entire machine building complex of the country. But here one should not forget that we are performing this work by no means in a void. High-performance machines of the continuous casting of slab blanks, equipment for the automation of various welding operations, including underwater operations, the largest furnaces for the production of forging ingots, unique hydraulic presses, various types of advanced power equipment, advanced metal-cutting machine tools, and rotary automatic lines have been developed in the Soviet Union. I can state with

full responsibility that the country has the most advanced models of new technologies and equipment for the majority of sectors of the national economic complex.

The Duplication of What Is Advanced

Now the most important thing is to "duplicate" more rapidly these achievements, which will contribute to the qualitative transformation of all the productive forces of the country. During the next 5-year period we need to speed up the growth rate of machine building by 1.5- to 2-fold and to change over to the output of machines and equipment of new generations. This will open the way to the automation of many production processes, to the use of the most advanced technologies, and to the decrease of the share of manual and difficult physical operations in industry.

In order to make all this a reality, we are sharply accelerating the development of science and technology, especially their priority directions, and are increasing the amount of basic research which has a direct outlet into engineering practice.

Displaying particular concern for the development of science, the party has posed today for Soviet scientists new responsible tasks, which correspond to the importance and scale of the present crucial historical stage. Soviet scientists fully understand the enormous responsibility, which is being placed on them, and will spare no efforts to justify the great confidence of the party and to implement the decisions of the 27th CPSU Congress.

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AUTOMATED SYSTEMS OF PETROLEUM, GAS INDUSTRY CONSTRUCTION

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 10, 20 May-2 Jun 86 p 4

[Article: "The Electronic Correspondent Reports...."; first paragraph is NTR: PROBLEMY I RESHENIYA introduction]

[Text] Today we are publishing a report which was prepared by the "electronic correspondent" of the press center of the Ministry of Construction of Petroleum and Gas Industry Enterprises. The memory of the automated system, which is called the Electronic Bulletin of Information, contains thousands of facts on the progress of the work of the sector. In just a few minutes it "examines" the information recorded on magnetic disks, "arranges" it with new facts, and immediately prints a text ready for the press.

Nearly all the projects under construction, including the largest construction project of the five-year plan--the Yamburg system of main gas pipelines with a total length of more than 28,000 kilometers--are now under the control of electronics in the Ministry of Construction of Petroleum and Gas Industry Enterprises.

The recent placement into operation of the new automated data processing complex of the computer center of the ministry is making it possible to speed up the establishment of another five automated control systems. They will encompass the production activity of all technological flows, trusts, enterprises, associations, main administrations, and the sector as a whole. Moreover, specialized systems are being established: the ASU-finansy, ASU-komplektatsiya, ASU-trudoustroystvo, ASU-remont, and others.

As a whole the capacity of the computer complexes of the Ministry of Construction of Petroleum and Gas Industry Enterprises during the 5-year period will increase by twofold. By 1990, 7 information and computing centers, 50 computing and management complexes, hundreds of personal computers, and 2,300 automated information processing stations will be in operation in the sector. All the expenditures on the establishment of such a developed electronic computer network will be recovered during this five-year plan.

PHOTO CAPTIONS

1. p 4, left. G.V. Chizhova, chief of a shift of the department of the gathering and teleprocessing of data of the computer center, establishes contact with Yamburg.

2. p 4, right. In the computer room.

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SYSTEM OF INFORMATION ON FUTURE EQUIPMENT

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 10, 20 May-2 Jun 86 pp 4-5

[Article by Candidate of Economic Sciences M. Karpunin and Candidate of Technical Sciences R. Vcherashniy under the rubric "The Problem Close Up": "Information on Machines Which Do Now Yet Exist. The Conceptual Design of a System of Information on Equipment of the Future"; first paragraph is NTR: PROBLEMY I RESHENIYA introduction]

[Text] Scientific and technical information is at the center of the concept being presented. But let us begin, perhaps, with a warning. The designer, who orients himself toward an analog, including a foreign analog, which corresponds to the highest world achievements, is automatically dooming his future machine to lagging behind. Nothing except common sense is needed in order to overthrow this reference point, which in recent times has become very fashionable. Indeed, during the time, which research and development, the introduction and duplication of the "new design," which was cut in accordance with the mentioned fashionable last, will consume, it will itself, just as the design which is oriented toward it, lose its novelty and attractiveness. Hence, the most reliable and complete summary of the best models of operating equipment, if it can correctly orient commercial practice (moreover, far from every time), can by no means orient the strategy of scientific and technical progress. This situation to a certain degree was taken into account in the recent decree of the State Committee for Science and Technology and the USSR Academy of Sciences on the establishment within the State Scientific and Technical Information System of problem-oriented databases. Now it is a matter of practical steps in this direction, and before that in the development of specific conceptual constructions which contribute to the formation of ideas about equipment of the future.

Three Faces of the Future

A few words about the intervals, to which there should be extended the foresight of the designer, who is capable of moving not in pursuit of already implemented scientific and technical achievements, but past them, so that at the point of entering into mass use the design would be the highest level, which it is impossible to copy, but the designer himself must predetermine by his own creativity.

Under the conditions of the socialist planned economy three such intervals are clearly discernible.

The first is the look a year ahead, the annual plan. Within this framework the specialists of the administration deal with already developed designs, which await introduction or are being series produced. Knowledge of the best domestic or foreign analogs makes it possible to settle the questions of only the modernization, reduction, or expansion of the production of some models of equipment or others.

The second interval is the five-year plan. The new equipment, the production and assimilation of which are planned for such a period, as a rule, already exists as technical solutions, but they still have to be embodied in technical specifications, then in metal. Here it is necessary to select the optimum ratio of systems and complexes of machines, to evaluate the economic advisability of the production of the new equipment, and to establish the entire group of users--obvious and potential users.

The third time interval is the future period of 10-15 years. During this time new generations of equipment are developed and new revolutionary technologies take shape. They are formed as means of achieving specific socioeconomic goals for the long-range future.

The next such period of scientific and technical progress in the field of machine building was clearly spoken about in the decisions of the 27th CPSU Congress:

"Machine building is called upon to produce systems and complexes of machines, equipment, and instruments of the highest technical and economic level, which ensure revolutionary changes in the technology and organization of production, the multiple increase of labor productivity, the decrease of the materials-output and power-output ratios, the improvement of product quality, and the increase of the output-capital ratio."

A new information strategy is also necessary in order to develop "information prototypes" of equipment and technology, which revolutionize social production.

Machines, Systems, Complexes

For the continuation of our discussion it is necessary to give if only predesign definitions to several concepts.

In case of the introduction of the methods of functional designing (in particular, the functional cost analysis) the situation, when a choice has to be made from some set of functionally identical units, is frequently encountered. Thus, an electric motor, an internal combustion engine, a turbine, a pneumatic or hydraulic motor, a jet engine, and so on can perform the work of a drive. By the way, here the group of basic functions (heating, the transfer of momentum, the transmission of a signal, the working of materials, and so on) is quite limited.

At the same time in technology there is not yet a generally accepted concept which unites tools of labor of the same functional purpose. The corresponding planning is also not being practiced. Equipment for the most part is produced in banks which have formed within the corresponding producer sectors. Therefore, for example, the power characteristics and other parameters of the drives, which are based on different principles which have formed in various sectors, might also not coincide.

Let us define the set of equipment of the same functional purpose, which is used as basic or built-in assemblies or units, as a set of machines.

A complex of machines is seen as a set of equipment, which is oriented toward one technology or another, in particular, toward the obtaining of specific types of products, materials, energy, and so on.

The optimum combination of the functional and material elements in case of the development of promising technical systems is dependent precisely on the socialist system of production and its planned regulation, which is aimed at the meeting of social needs. This affords the possibility of shifting from the formation of theoretical notions of individual objects of new equipment to a qualitatively different one--the systems planning of interconnected systems and complexes of machines and their practical implementation in objects of equipment of new generations. Here the most advanced and economically efficient solutions, which make it possible not to improve individually taken separate machines, but to update interconnected systems and complexes, are achievable.

The level of each component, which is included in such a system or complex, should be determined with allowance made for the basic postulates of systems engineering. For example, the set of the best machines, which are included in the complex as a component of it, does not yet predetermine the optimum state of the entire complex of machines, which is oriented toward a specific technology....

Let us note that the choice of standards for the evaluation of the level, which corresponds to present notions, of promising equipment is a quite difficult task. It has not yet been backed by procedural recommendations. Its accomplishment is necessary for the adjustment of the interaction of the main enterprises and organizations of different departmental affiliation. In other words, for the practical implementation of the unified state technical policy in the area of the development of the machine building complex of the country.

It must be said that we could have been better prepared for all this, if we had dealt more consistently and systematically with the evaluation of the level of individual machines.

Back in 1981 the State Committee for Science and Technology, the State Committee for Standards, the State Planning Committee, and the State Committee for Material and Technical Supply adopted a decree on the introduction of the systematic evaluation of the technical level of the quality of machines, equipment, and other machinery for the certification of these products by

categories of quality. In addition to the traditional evaluation of the finished products the evaluation of the level of the technical assignment, the elaborated technical specifications, and the prototypes of the equipment being developed was also introduced.

Unfortunately, in the past 5 years the necessary efforts for the introduction of such an order were not made--the proper information base was not placed under the evaluation of the technical level.

Information Prototypes

New results of basic science cover a long path in 7-8 years before they are embodied in real machines and instruments. This means that the outlines of new generations of equipment are originating already today in the laboratories of academic institutes. It is necessary to carry this new knowledge in a new way to those who determine the long-range future, particularly through the State Scientific and Technical Information System.

Therefore, the need for new forms of the interaction of the information services of the USSR Academy of Sciences and the higher educational institutions of the country and sectorial information centers is arising. Computer-oriented information models of future machines and their complexes and systems, which are based on new principles of operation, should be built by this triad. Work of this sort is also already being performed and developed, by the way, at a number of higher educational institutions of the country.

The most precise formulation of the socioeconomic demands on technical systems of future generations and the consideration of the permissible socially necessary expenditures of labor on specific technologies, the periods of the amortization and replacement of the equipment being developed, the prospects of the development of the export potential, and a number of other general economic conditions are necessary for effective information modeling. So far a generally accepted methodology of performing work of this sort has not yet been established. But it is necessary in order to develop equipment which is not simply better than operating equipment. It is important that the new machines would satisfy economically and most completely the production and socioeconomic needs which will arise by the moment of their entry into mass use.

In our opinion, the work oriented in this manner should be organized within the framework of the complexes being formed in the country--agroindustrial, machine building, fuel and power, and so forth.

The information centers of the all-union and sectorial levels should actively join in this work on an equal footing with the leading scientific centers and interbranch scientific technical complexes. Here the main attention should be devoted to the carrying over of technical solutions from one field of knowledge to another, and special attention should be devoted to carrying it over interdepartmental barriers.

It is here that temporary scientific collectives should play their role in particularly crucial situations. Within them it is easiest of all to coordinate the actions of specialists from organizations of various departments, the USSR Academy of Sciences, the State Planning Committee, higher educational institutions, and sectors of the national economy.

Within the Five-Year Plan

The evaluation of the level of the technical solutions and specifications being developed is a most important component of the formation of long-range ideas of the properties of the systems and complexes of machines, which are being developed. All-Union State Standard 15.001-73 "The Development and Placement of a Product Into Production" with the subsequent supplements stipulates that the technical assignment is drawn up (and, consequently, is also evaluated) on the basis of "the results of the performed scientific research and experimental work, scientific forecasting, the analysis of advanced achievements and the technical level of domestic and foreign equipment, promising ranges and systems of machines, equipment, and other machinery, the study of patent documents, and for products intended for export, with allowance made for the requirements of the foreign market."

The indicators of the competitive ability are of great importance for the evaluation of the technical specifications at the stage of development. (Footnote 1) (At times the competitive ability is unjustifiably identified with the indicators of the technical level. However, this is a narrow interpretation of this concept, since the competitive ability is determined not only by the technical parameters, but also by the cost of consumption (the expenditures on acquisition and use))

It is further indicated that the demands, which are included in the technical assignment, should be based on the present achievements of science and technology and "the need for the assurance of leading indicators of the technical level of the product."

When evaluating specific machines it should be taken into account that the present level of technology, which is reflected in the documents, particularly patent documents, cannot always be described by the characteristics of future objects of equipment. This level, as a rule, is determined by something else--the set of technical solutions. Precisely the scientific and technical potential of a solution also ensures the attainment of new levels by equipment.

Consequently, when evaluating the level of equipment from this standpoint the principles, which are close to the scientific and technical appraisal of inventions, are sooner applicable, since the need for the comparison of the logical formulas of technical solutions arises. For the present we still do not, unfortunately, have the corresponding methods of automating similar procedures.

In this connection it is necessary to note that one must not limit the determination of the level of equipment, which is reflected in already elaborated technical solutions, to the search for information only about such

solutions. Patent statistics research is of greater and greater benefit. However, for this it is necessary to process large amounts of information, particularly the data on inventing activity and the patenting of technical solutions. That is, it is necessary to obtain an evaluation of the trends of the movement of scientific thought, which is capable of identifying the path of the progressive development of equipment and technology during a specific future time period.

Annual survey reports, which are prepared by information organs of all levels, can become an important tool of the substantiation of technical systems, the development of which is envisaged, for example, by five-year plans. The status of this work, which is envisaged by All-Union State Standard 7.38-72, does not, however, satisfy the urgent requirements. The basic shortcoming is that each information institute autonomously seeks and describes what, in its opinion, is the present level of developments.

It would be more natural for the State Planning Committee or the State Committee for Science and Technology to act as the client of this work, directing the attention of its performers toward priorities which are actually urgent for the national economy. Here the All-Union Institute of Scientific and Technical Information of the State Planning Committee and the USSR Academy of Sciences would prepare a report on the status and results of basic research, the All-Union Scientific Research Institute of Patent Information of the State Committee for Inventions and Discoveries would compile a survey of the corresponding new technical solutions, the All-Union Scientific Research Institute of Technical Information, Classification, and Coding of the State Committee for Standards would coordinate all this with the demands of the users on the quality, while sectorial information organs would analyze the possibilities of the implementation of the new solutions. In other words, a systems organization of the work is needed here.

It is probably necessary to assign to the newly organized All-Union Scientific Research Institute of Problems of Machine Building of the State Committee for Science and Technology the elaboration of the criteria of the optimization of the demands on technical objects with allowance made for the conditions of the formation of systems and complexes of machines. One should also think about the functional diagnosis of the machines and devices being designed as a new section of the planning of the technical sphere.

Knowledge of the present level of technology is also necessary for the choice of the organizational means of achieving the set goals. The development of new objects of equipment is possible by various means: by research and development proper, by means of scientific and technical collaboration or production technology cooperation with foreign partners, by the purchase of licenses, by means of imports, and by other methods.

The method of the alternative analysis, which precedes the choice of one version or another of the achievement of the given level of technology, has not yet found extensive application in the practice of the machine building ministries. In many respects such a choice is still of a subjective nature. The consequences of such an approach have been repeatedly criticized in the press.

Know the Operating Equipment!

The certification of the items being produced, which is carried out primarily with respect to foreign analogs, is the traditional procedure of evaluating the level of technology of today. Meanwhile such an approach is far from always justified. First, here the quality of items, which is economically justified under specific conditions of the national economy, is ignored; second, the conditions of competition, especially on the markets of the developed capitalist countries, give rise to many abnormal phenomena, which frequently distort the real notion of the optimum properties for our conditions of new equipment, its range, and so on.

The orientation toward foreign analogs overshadows the main thing--the real demands of domestic consumers on new equipment. Serviceability, the real mean time between failures, the actual specific consumptions of raw materials, fuel, and energy, the causes of failures, maintainability, the efficiency proposals of operators, the complaints of foreign users, and so on and so forth--far from all these concerns of the user are known to the designer.

The gathering and centralized processing of information on the quality of the items being produced and the analysis of the complaints being lodged by users are the type of most urgent information, which still has to be organized. But meanwhile the more and more urgent need to use such information more actively for the improvement of the equipment being produced and for the lodging of complaints against the sectors, which supply components, is arising.

With reference to each system or group of machines, the level of which it is necessary to evaluate objectively, the most essential attributes, properties, and characteristics, first of all from the standpoint of the user, also still have to be identified. An objective idea of the equipment being produced can be developed only on such a basis.

Information Bases of a New Type

The development of effective systems of the information support of the procedures of the evaluation of the present and future levels is an urgent task. It is for its accomplishment that hypothetical models of equipment of the future are needed. What we called "information prototypes."

Obviously, such models can be dynamic structures which change in time and space. Their individual characteristics can change their values: some attributes will lose urgency, others will arise anew.

This means that the database, which contains the information on the conformity of the properties of the equipment being developed to a given level, which is necessary for appraisal, cannot be something that has been created once and for always and is frozen.

Frame structures (see the diagram [diagram not reproduced]), which are "fed" in accordance with a special algorithm from documentary and factual

information retrieval systems, may prove to be the most acceptable basis, in our opinion, for the formation of such bases.

Unfortunately, the popular opinion that it is possible to solve any information problem, having established a database, still exists.

But all bases are not alike!

In one case it is sufficient to put on conditional "shelves" a certain set of characteristics of some ordered number of items. But it is far from easy to break down by shelves the properties and peculiarities of machines and technologies, which it is impossible to describe in parametric form.

This, however, does not mean that the traditional methods of evaluating machines and instruments have lost their topicality. The use of operating factual retrieval systems, which contain information on domestic and foreign analogs, is productive for the certification of technologically assimilated equipment. Here one can also not do without the centralized processing of the accompanying documents for imported equipment.

The development of methods of the formation and functioning of databases for the evaluation of the level of technology dictates the need for the combining of the efforts of specialists of organizations of the USSR Academy of Sciences, the State Committee for Science and Technology, and the leading sectorial centers of information on machine building. It is necessary to introduce in such databases the information which is used in the practice of the economic management of the level of equipment. It is necessary to integrate these bases into the entire system of the management of scientific and technical progress, having ensured their coordination with its remaining elements.

Owing to the particular importance of such a class of operations, their difficulty, and labor intensiveness they should be included in the national economic plan as special, state-priority research with the appropriate legal, material, and technical support.

DIAGRAM CAPTION

Any machine can be represented in the form of a functional model. The main function--the purpose of the machine--is achievable in combination with auxiliary functions (see the upper block of the diagram).

At the basis of each function is a physical or another effect. It also determines the principle of operation. A set of models of the principles of operation, which can be of an alternative nature, corresponds to each function (see the middle block of the diagram). Technical solutions are needed in order to realize the principle of operation in an operating machine (see the lower block of the diagram). It is possible to realize any principle of operation by a specific number of different technical solution.

Thus, each principle of operation "generates" a block of technical solutions, which corresponds to it. The designer chooses the most effective combination

of solutions when developing new objects of equipment (since this is shown in the diagram by intrablock and interblock arrows).

The acceleration of scientific and technical progress requires the reliable choice of the most effective solutions, while this involves the looking over of a large group of alternatives. Frame structures, by making it possible to encompass and rank them, create the prerequisites for the effective application of mathematical economic methods and computer hardware for the predesigning forecasting of future generations of machines and their systems and complexes--with the desired properties.

7807
CSO: 1814/249

BRIEFS

RIGA COMPUTER-AIDED DESIGN CENTER--A computer-aided design center (SAPR) in machine building has been organized on a shared basis at Riga Polytechnical Institute. Seven republic ministries and a number of enterprises of union subordination, which are located in Latvia, are financing its activity. All of them have become not only founders, but also clients of the new subdivision, which offers long-term services to machine building and instrument making organizations. The center has concluded and is concluding contracts for the development and introduction of computer-aided design systems of technologies, machine tool attachments, and the control of technological processes with tens of industrial enterprises. Among them are such well-known firms as VEF (a computer-aided design system of means of communication and technologies of their production), the Riga Bus Works (a computer-aided design system of bodies of microbuses), Radiotekhnika, the Riga Electrical Machinery Plant, and so on. [Text] [Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 4] 7807

AUTOMATION OF KUTAISI DYE PLANT--Creative groups of engineer-efficiency experts, without purchasing new equipment, have automated the majority of labor-consuming processes at the Kutaisi Plant, which produces dyes. The innovative collective is working on a contract, the expenditures are being reimbursed by the profits obtained from the economic impact, the level of which determines the amount of the monetary award of the participants. [Text] [Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 4] 7807

ARSENAL PLANT FLEXIBLE MACHINE SYSTEM--The operation of the automated section of NC machine tools, which was converted into a flexible machine system, was improved with the participation of members of the multiple-skill creative youth collective at the Kiev Arsenal Plant. The research was performed within the framework of the long-term Reserves Program, which was drawn up on the initiative of the Komsomol committee of the enterprise. The new resource-saving technology made it possible to establish a continuous rhythm of the shop and to decrease the consumption of metals and electric power. [Text] [Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 5] 7807

CSO: 1814/249

DEVELOPMENTS OF INSTITUTE OF MACHINE SCIENCE

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8, 22 Apr- 5 May 86 p 4

[Article: "Developed at the Institute of Machine Science of the USSR Academy of Sciences"; first two paragraphs are NTR: PROBLEMY I RESHENIYA introduction]

[Text] An extensive series of basic research, the results of which are finding extensive application in various areas of the national economy, is being conducted at the Institute of Machine Science imeni A.A. Blagonravov of the USSR Academy of Sciences.

Today we are telling about only six such developments.

The hydrated nontoxic lubricating compound is intended for the replacement of mineral oils in transmissions of the closed type (toothed and worm reduction gears), as well as in hydraulic systems at space temperatures of not more than 80 degrees Celsius. This compound is nontoxic, dissolves well in water, and does not cause pollution of the environment. It has successfully undergone production tests at several enterprises of Ivanovo Oblast. The annual total impact from its use at three enterprises in case of the replacement of I-20 industrial oil came to 200,100 rubles.

The laser hardening of the parts of agricultural equipment, which operate under the conditions of intense friction wear, leads to the substantial increase of the hardness of the surface layer. The advantages of the method are a high speed of machining and the minimum distortion of the form of parts. The wear resistance increases by two- to fivefold. The anticipated economic impact is 1.7 million rubles.

Brittle strain-sensitive coatings make it possible--in accordance with the nature of the propagation and density of cracks in them--to identify the zones of the greatest and least strains, to determine at each point of the surface the direction of the main tensile and compressive strains, as well as to estimate their magnitudes. This makes it possible to decrease to a significant degree the time and amount of planning, design, experimental, and calculating work, which is connected both with the choice of the optimum version of the design and with its operational development during bench and full-scale tests.

The introduction of such a method at the Taganrog State Special Design Bureau for Machines for the Harvesting of Grain Crops and Self-Propelled Chassis yielded an economic impact of 300,000 rubles.

The fixed-stop high-speed industrial robot with power regeneration makes it possible to remove the operator from the danger zone of the press and frees him from monotonous labor when prefabricating blanks. Labor productivity was increased, as compared with other types of fixed-step industrial robots, by 2.3-fold, while the power consumption was reduced to one-tenth to one-eighth.

A commercial test run of such robots has been produced. The economic efficiency from the introduction of each of them is 2,500 rubles a year.

The self-lubricating materials with new solid lubricants, which were obtained by the method of chemical heat treatment and powder metallurgy, gave a good account of themselves in case of operation in assemblies of dry friction of high-vacuum systems, in case of rolling in a vacuum, and in electric vacuum equipment. They are making from them slip bearings, bearing cages, taper rollers of antifriction bearings, and spur gears. The economic impact from their introduction came to 1 million rubles.

The measuring head for NC machine tools makes it possible to obtain information about the geometric parameters of the surfaces being machined. As compared with domestic and foreign analogs it is distinguished by design simplicity, a lower cost, and high reliability. The head makes it possible to receive several command signals which are used in the control system of the machine tool. This, in turn, makes it possible to shorten the time of measurement. The economic efficiency from the use of such heads on the NC lathes of the Krasnyy proletariy Plant comes to 515,000 rubles a year.

7807
CSO: 1814/249

INSTRUMENTS OF SPEKTR SCIENTIFIC PRODUCTION ASSOCIATION

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8, 22 Apr-5 May 86 p 5

[Interview with Doctor of Technical Sciences V.V. Klyuyev, director of the Spektr Scientific Production Association, by B. Smagin: "The Spectrum of Spektr; date, place, and occasion not given; first two paragraphs are NTR: PROBLEMY I RESHENIYA introduction]

[Text] The vibration acoustic instruments, which were developed at the Moscow Spektr Scientific Production Association, are making it possible to forecast the behavior of rubbing, rotating, and even static parts of diverse systems of modern equipment--from a motor vehicle to pipes of gas pipelines, which are many kilometers long.

Doctor of Technical Sciences V.V. Klyuyev, general director of the association, relates:

[Answer] I will begin with the study of the state of bearings, since the corresponding monitoring system has been set up well and is being produced in series. How is this work organized, for example, at such a large enterprise as the Moscow Metro?

Until recently operational inspections of all the bearings without exception of all the trains of the metro were conducted there precisely according to schedule. They took the bearings apart, changed the grease, and reassembled them. You yourself understand that this is inconvenient and expensive and by no means insured against possible troubles. The majority of inspected bearings proved to be entirely suitable for further use; others, on the contrary, had failed, without waiting their "turn" in the schedule of operational checking.

What did the changeover to contactless monitoring by means of instruments of vibration acoustic diagnosis yield?

All the shortcomings of the customary practice of inspections immediately came to light. It turned out that a large percentage of the bearings, which had worked the time which was assigned to them in accordance with the regulation, nevertheless did not require any intervention.

But many bearings, which proved to be close to a state of failure long before the time of mandatory inspection, were also found.

The economic contribution of the other group of instruments, perhaps, will be more significant, since it is a question of the diagnosis of various "diseases" of power-generating units. Here it is possible to use vibration diagnosis, so to speak, in pure form, since, say, the vibration status of a shaft reflects the quality of its operation and all the possible deviations from the set conditions.

Several parameters are measured simultaneously, moreover, the monitoring of the state of the bearings is also included here.

If the parameters being measured reach a level which is dangerous for the further operation of the unit, the system automatically shuts it down.

The Kiev Veda Production Association is series producing such systems of the vibration acoustic monitoring of the activity of turbines of electric power plants.

The third task, which is being accomplished with the aid of instruments of vibration diagnosis, is the assurance of the stable operation of gas pumping stations.

We have already developed the corresponding equipment, moreover, we can say with pride that one of our instruments--the VVM-337, a portable vibration diagnosis instrument for the inspection of gas pumping stations--with respect to its parameters is the best in the world!

And, finally, about the fourth type of our technical diagnosis units, in which vibration effects are used. It is intended for a large group of installations of the petroleum industry.

The petroleum industry is an extremely complex system. A large number of different pumping systems, including pumps and many units, operate here in an independent mode. It is natural that special attention to the assurance of the proper conditions of their operation is needed.

I would like to note that our work is not limited only to vibration diagnosis. We were the first, for example, to begin work on the design of a measuring robot. This device, which is intended for the performance of control and measuring operations, does not have analogs in world practice. Such robots will replace many thousands of people, who are now engaged in routine operations of the checking of the quality of all industrial products.

PHOTO CAPTIONS

1. p 5, top. The VVM-337 portable vibration diagnosis device is intended for the monitoring of the vibration of gas turbine plants for gas pumping stations. By means of it they carry out the balancing of the shaft drives of turbines and compressors.

2. p 5, middle. The AD-60S acoustic flaw detector is used for detecting flaws in items made of laminated plates and multilayer components made of nonmetallic and metallic materials.

3. p 5, bottom. The ISP-1 indicator of the state of bearings is used for the functional diagnosis of rolling bearings in the process of operation. The reliability and durability of machines and devices are increased due to the timely detection of damages and flaws. The method of nondestructive testing is realized in the instrument.

7807
CSO: 1814/249

BRIEFS

EQUIPMENT DEVELOPED BY STUDENTS--Student scientific production detachments have existed for more than 15 years at the Moscow Higher Technical School imeni N.E. Bauman. During the summer the students bring up "to metal" the scientific research work performed during the year. More than 150 detachments have already introduced about 100 models of equipment. In the photos [Photos not reproduced]: 5th year students Sergey Vagner and Aleksey Kotov and chief engineer Aleksey Mikhaylovich Dryganov work on the improvement of a trainer; Sergey Volkov and Aleksey Kotov discuss a new idea. [Text] [Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 4] 7807

SIBIR SHAFT SINKING COMPLEX--The new Sibir complex, which is intended for the sinking of mine shafts, covered the path from the drawing to the commercial series in just 2 years (for comparison let us recall: its predecessor got to the plant shop only in the 8th year). The speed up was achieved owing to the uniting of the forces of the Kuznetsk Scientific Research Institute of Mine Construction and the miners of the Kuzbass Coal All-Union Industrial Association, for which the innovation is intended. They rejected the system of introduction, which has been adopted in the sector, and proposed their own, in accordance with which the developments of scientists are materialized in metal directly at the enterprises of the association. The production of the Sibir has been assigned to the Krasnyy Oktyabr Plant (Leninsk-Kuznetsk). The first batch of devices will arrive at the mines already at the end of this year. [Text] [Moscow NTR: PROBLEMY I RESHENIYA in Russian No 11, 3-16 Jun 86 p 5] 7807

CSO: 1814/249

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